Wave-powered SeaRAY preps for Hawaii trial

August 23 2021

The Modular Ocean Data Acquisition system's fortified data collection system will process, clean, and display data from about 70 different sensors aboard the SeaRAY. Here, water power research technicians Mark Murphy and Andrew Simms prepare the device for more rigorous checks. Credit: Vern Slocum, NREL

Offshore industries, like marine research, fish farming, and mineral mining, often rely on big ships with large crews. Without clean energy to power these vessels, each trip out to sea and back to shore is not only expensive but also carbon intensive. You cannot charge that ship by plugging it into the ocean.

Or maybe you can.

An autonomous, wave-powered, renewable energy device—called the SeaRAY autonomous offshore power system (AOPS)—could power offshore work and help protect our oceans and climate, too. The SeaRAY AOPS not only makes and stores clean, carbon-free energy, but it also shares data with the offshore vehicles it powers. Designed by C-Power, the SeaRAY AOPS could provide clean energy for offshore activities, including aquaculture (like offshore fish farms), mining, oceanographic research, military missions, methane leak monitoring at underwater oil and gas wells, or even desalination for remote communities and natural disaster recovery.

"Anything you can think of," said Andrew Simms, a research technician at the National Renewable Energy Laboratory (NREL), "SeaRAY can power offshore."

The global ocean economy is expected to double from $1.5 trillion to $3 trillion by 2030. Powering this economy with renewable energy is critical to protect these vast and vulnerable waters, which house about a million species, 17% of the world's food supply, and 70% of its oxygen.

To prove the SeaRAY AOPS can help power this so-called blue economy, C-Power partnered with NREL and the U.S. Department of Energy Water Power Technologies Office to prep the device for its first open ocean trial.

"NREL has a critical role in this project," said Reenst Lesemann, C-Power's chief executive officer. "They're not only helping provide the brains of the AOPS but also helping with testing and debugging the system before we get into the water."

To make sure the SeaRAY AOPS is ready for a six-month oceanic trial at the U.S. Navy Wave Energy Test Site in Hawaii, NREL researchers are simulating rolling ocean movements at the laboratory's Flatirons Campus in Colorado. With NREL's novel field data collection and control system, called Modular Ocean Data Acquisition (MODAQ), the team will check that SeaRAY AOPS can operate as intended while rocking with ocean waves.

"We're treating this like a satellite," Simms said. "Before we deploy, everything must be right to achieve successful power generation in Hawaii and elsewhere. We need to walk before we run."

The SeaRAY AOPS can be smaller or larger to meet specific needs, generating between 100 watts and 20 kilowatts—enough energy to power anything from a seafloor data-gathering system to a medium-sized subsea vehicle or surface vessel. On the ocean's surface, a wave energy converter captures and transforms wave motion into electricity, which is then stored on the SeaRAY and in a seafloor battery. At the same time, the SeaRAY collects, stores, and delivers data both from and to the device it powers and between the SeaRAY and its handlers on land.

"You can think about an AOPS as a charging station, a data server, and a cell tower out in the ocean," Lesemann said.

In Hawaii, project partners, including Saab—a world leader in electric underwater robotics—the National Oceanic and Atmospheric Administration, and BioSonics, will pair the SeaRAY AOPS with their electronics, which collect data on methane and carbon levels, fish activity, and more. Normally, autonomous underwater vehicles like Saab's need power from a topside ship that emits about 7,000 cars' worth of carbon dioxide per year; the SeaRAY can prevent those emissions.

Andrew Simms helped build this field data acquisition system (known as MODAQ), which uses clean energy from ocean waves to collect and store data in the cloud. Credit: Vern Slocum, NREL

"With Saab," Lesemann said, "we're looking to show that you can avoid that carbon dioxide production and, at the same time, reduce costs and operational complexity while enabling autonomous operations that are not possible today."

To send all that data back to those partners in real time, the SeaRAY AOPS needed a brain: MODAQ. Originally designed to standardize and increase the quality and breadth of field data collection, the first MODAQ could do basic data acquisition and condition monitoring (meaning that it kept track of how a wave energy device performed). SeaRAY's fortified MODAQ is yet another acronym: a supervisory control and data acquisition, or SCADA, system. Now, the tool not only collects field data, but it also sends information to the cloud and connects to the web so customers can watch a live SeaRAY performance, receive data on how a device is functioning, or even control those functions from a desk halfway around the world.

"Our ultimate goal," Simms said, "is to provide a fast, reliable, and robust data acquisition and control system that can upload, process, and display data to a client in near-real time."

That is no easy feat. SeaRAY has about 70 sensors that collect massive amounts of data. To handle all that information, the team expanded their system, making it the largest, most complex MODAQ yet. Normally, that kind of development takes four years. The NREL team did it in one.

But before MODAQ goes underwater with SeaRAY, the team must protect it from a corrosive and violent ocean.

Out at sea, salt can decay exposed machinery, crashing waves can damage cables, and the conductive saltwater can cause something called galvanic corrosion; when two different metals are submerged in a conductive solution, one can deteriorate at a different rate than the other. "Everything needs to be splash-proof and saltwater-rated," said Mark Murphy, an NREL research technician. And, to thwart galvanic corrosion, he continued, "we had to make sure we weren't mixing and matching metals in the water."

Open-ocean testing presents another challenge: constant, sometimes violent motion. To make sure the SeaRAY AOPS runs well even in turbulence, the NREL team attached it to a dynamometer, a machine typically used to test wind turbine generators. To put SeaRAY through the motions of the ocean, the NREL engineers designed an entirely new test rig—a hydraulic dynamometer—that better simulates rocking waves and currents. A hydraulic dynamometer, which uses fluids to power a motor and rock the SeaRAY, can switch direction much faster than an electric motor, which spins at great speeds but is not as nimble.

"With a hydraulic motor, there's not nearly as much inertia, and you can change direction," said Scott Lambert, a mechanical engineer at NREL who designed the new hydraulic dynamometer from scratch. "That's important when you want to change direction constantly to simulate waves."

SeaRAY's wave energy converter uses two floats, one on each side, that roll with ocean waves and connect to a power-take-off system—a mechanical machine that transforms that motion into energy. That system then runs a generator. And that generator connects to batteries on the seafloor, a storage system that NREL Research Engineer Ismael Mendoza will also test out before the sea trial. "The first time the storage system and SeaRAY meet is in the ocean," Mendoza said.

This fall, the SeaRAY team will pack their device into a standard shipping container and send it to Hawaii. There, a small boat will tow the technology to its ocean test site. This easy transport is purposeful; C-Power made sure its wave-powered device could be transported anywhere in the world with few logistical barriers and with minimal cost, crew, and carbon emissions.

Once the open ocean field test is complete, the MODAQ system will provide the C-Power team with data to further improve the SeaRAY device and make it even smaller, lighter, more efficient, and more adaptable for a wider range of applications.

"I think we did a good job," Simms said. "We're about to find out."

Provided by National Renewable Energy Laboratory

Citation: Wave-powered SeaRAY preps for Hawaii trial (2021, August 23) retrieved 27 April 2024 from https://techxplore.com/news/2021-08-wave-powered-searay-preps-hawaii-trial.html