



Florida Atlantic University
Southeast National Marine Renewable Energy Center (SNMREC)
(Progress Report)

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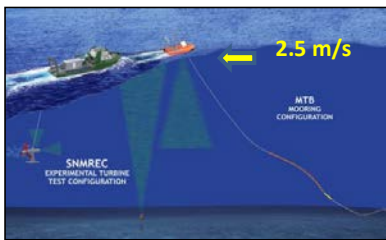
Students: Student listing is appended

Description: The Southeast National Marine Renewable Energy Center (SNMREC) at Florida Atlantic University (FAU) was established by an award from the US Department of Energy in 2010 as an extension of FAU's Center for Ocean Energy Technology, which was originally founded in 2007 by the 2006 Florida State University System Center of Excellence Program. The SNMREC is investigating harnessing power from ocean currents, such as the Gulf Stream, as well as ocean thermal energy conversion to generate base-load electricity, thereby making a unique contribution to a broadly diversified portfolio of renewable energy for the nation's future. Key drivers for investigation are determined by the regulatory process at State and Federal levels and by market and technology gaps needed to commercialize MRE. The SNMREC's role is to bridge the gap between concept and commercial deployment of ocean energy technologies by providing at-sea testing facilities and technology development for both ocean current and thermal energy systems. Research areas span environmental, resource, economic, education, and technology topics.

Budget: \$8,750,000

Universities: Florida Atlantic University, collaborating with the University of Central Florida, Florida State University, University of South Florida, Embry-Riddle Aeronautical University, University of Miami, Oregon State University, University of Washington, Pennsylvania State University, University of New Hampshire, University of Hawaii, University of Edinburgh, Heriot-Watt University, Nova Southeastern University, Virginia Polytechnic Institute and State University, and Florida Institute of Technology.

External Collaborators: Numerous industry partners, state and federal government agencies, FFRDCs such as the National Renewable Energy Laboratory, Oak Ridge National Laboratory, Woods Hole Oceanographic Institution, U.S. Department of Energy (Office of Energy Efficiency and Renewable Energy), U.S. Department of Interior (Bureau of Ocean Energy Management, Regulation, and Enforcement), U.S. Department of Commerce (National Oceanic and Atmospheric Administration), the Florida Fish and Wildlife Commission, and Florida Departments of Agriculture and Environmental Protection.



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The Southeast National Marine Renewable Energy Center is developing an open-ocean energy laboratory and test capability to advance research on marine and hydrokinetic (MHK) ocean current energy and thermal





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potential energy. An offshore scaled device test berth (approximately 12 nm offshore of Ft. Lauderdale, FL) is under construction and will be installed to accommodate up to 100kW max instantaneous power production and/or 7m rotor diameter turbine testing. This initial group of industrial devices will provide insight into individual device extraction methods, dynamics, and basic system operability. A generic 20kW experimental research turbine is also under construction which will allow for subsystem or component testing and development and will be the initial test vehicle. In addition, it will provide methodology and support infrastructure available for commercial 1:20 scale prototype device testing.

The SNMREC is moving forward with strategically selected research, developing and testing key technology, infrastructure and systems as well as standards criteria to meet this need. The successful implementation of an in-water testing infrastructure for MHK off the coastline of Florida will be the first and only such capability globally. A centralized, standardized testing capability will be provided for testing current energy conversion prototypes; initially, scaled versions and eventually full-scale devices. In addition, critical environmental measurements will be obtained on a continuous basis from the observational platform and submerged instrumentation. Companies from both the U.S. and internationally are working with the SNMREC in defining test requirements based on their design, as well as both short term occupancy in Florida and potentially longer term manufacturing and grid connection options in developing arrays for commercial enterprises.

An MHK lease application on the outer continental shelf (OCS) initially submitted to the US Department of Interior, Bureau of Ocean Energy Management (BOEM) in 2010 will form the model for future lease applications. As this is the first such application in the U.S., BOEM decided to conduct the Environmental Assessment (EA) in-house in order to fully develop future guidelines for subsequent lease applications for the OCS. BOEM has been responding to comments from Florida State and Federal agencies, as well as other interested parties, and is nearing completion of the EA. It is anticipated that a Notice of Availability of a Final EA will be released in the Federal Register within this quarter. The State of Florida will conduct a Consistency Determination following the release of the EA; however SNMREC has continued to conduct ongoing dialogue with Florida State agencies to provide the most up to date information. Presuming a favorable EA outcome, SNMREC has been moving forward with a review of the general lease terms awaiting specific stipulations from the EA.



FIGURE 2. SNMREC 3-METER DIA ROTOR, 20KW INSTANTANEOUS MAX POWER PROTOTYPE TURBINE

A 3-meter rotor diameter, 20kW generically designed experimental research turbine (Figure 2) will provide a non-proprietary platform for component development at small scales. The test procedure/plan is laid out to incorporate monitoring and failure prediction systems, to gain experience in at-sea operations of this nature, and to support standards and protocol development. Industrial beneficiaries will be able to use the results of testing to enhance and accelerate prototype development. .

The SNMREC is engaged in sensor and instrument acquisition, deployment, and analysis to more fully characterize offshore energy resources, and the benthic and pelagic environment. Second, fabrication of a small-scale





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hydrokinetic turbine system is in the final stages of completion. Testing is ongoing for components, sub-systems, and major systems of the turbine. Assembly and tow testing of the prototype prior to deployment of the test infrastructure is on hold pending completion of the EA.

Sea trials were successfully conducted of a mooring and telemetry buoy to ready it for at-sea deployment. In-lab technology testing is underway with a scaled generator dynamometer which provides a platform to test offshore electrical systems before use and simulate offshore grids. Aerial surveys are being conducted to determine offshore turtle and marine mammal distribution and activity prior to install/test of MHK devices. Sub-sea surveys of installation sites are helping to identify deep water coral distribution and determine appropriate anchor areas.

One of the biggest unknowns in the operation of ocean current turbine (OCT) systems concerns the behavior of the generator sub-system as it experiences both variable loads and the torque differentials associated with changing currents acting on the rotor. In order to provide a capability to test generators and/or associated instrumentation under realistic conditions, the



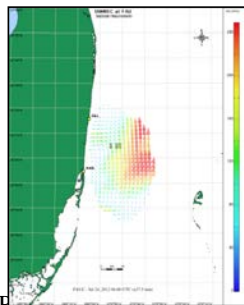
SNMREC has developed a computer-controlled dynamometer system, located at the FAU SeaTech facility in Dania Beach. This basic capability, subtask 10-1.3, has been further enhanced with simulated oceanographic conditions to emulate rotor behavior on the test stand as it would occur in an actual ocean

current. The 20 kW dynamometer has been fitted with the SNMREC's experimental research turbine power quality and health management systems, and has continued generating data for Prognostics and Health Monitoring (PHM) research. In addition, preliminary work has been completed to emulate rotor behavior in wave conditions and from collected offshore measurements. A laboratory capability feasibility study for ocean current turbine testing was completed, and the results are available in an M.S. Thesis format.

On May 22nd three Acoustic Doppler Current Profiler (ADCP) buoys were deployed. All three buoys were recovered in December. Velocity magnitude and direction with respect to time and depth data has been made available online. The plan is to refurbish the three buoys, add a fourth buoy and redeploy the buoys in a diamond configuration in May to begin to assess upstream and downstream flow variation for a six-month duration over the summer and fall.

As of mid-July of 2012, SNMREC's 12 MHz SeaSonde® radar system has been collecting

ocean surface current measurements (see figure for location of ADCP buoys in relation to SeaSonde® coverage area). The SeaSonde® system has been operating intermittently this quarter during its initial tuning phase where the primary focus is on evaluating and optimizing the surface current data quality. With the passage of Hurricane Sandy, however, wave action at the Hillsboro site caused serious beach erosion and, in the process, the northern of the two antennas was destroyed. However, data were obtained before the unit's loss to allow initial attempts to validate the SeaSonde® data by comparing to data collected from the ADCPs which were recovered in December. Early results suggest that, at least during periods of



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variable winds, such as during the passage of the storm, there is no correlation between CODAR-measured surface currents and currents throughout the water column. It appears that it will be necessary to adopt other strategies for continuous monitoring of the current.



FIGURE 3. AERIAL SURVEY AREAS OFFSHORE FT. LAUDERDALE, TO DETERMINE SEA TURTLE AND MARINE MAMMAL POPULATIONS.

Monthly aerial diversity and distribution surveys are being conducted to assess sea turtle and marine mammal populations. The surveys employ the currently accepted protocol – human observers viewing transect areas from a plane flying approximately 500 ft. from the ocean surface. Twenty-four months of cross-channel and over 40 coastal surveys have been completed to date. Additional along-shore surveys with available historical data are underway. Because preliminary data suggests significant population activity near shore, these transects will provide higher resolution data to support analysis efforts. The research team is working with the National Oceanic and Atmospheric Administration’s, National

Marine Fisheries Service to evaluate the SNMREC’s enhanced approach as an expansion of currently accepted methods. The survey areas currently being assessed are depicted in Figure 3.

The SNMREC, with FAU’s Harbor Branch Oceanographic Institute (HBOI) has established an internship program for up to 4 United States Coast Guard Cadets. The cadets will participate during their summer rotation, starting in the summer of 2013. The cadets have submitted applications to participate in the program, and the SNMREC and HBOI are currently reviewing the applications for selection to the program. This program will enhance cooperation between the U.S. Coast Guard and the SNMREC while educating future officers about projects which will be installed in coastal areas.

SNMREC staff is working with professors and students at FAU’s School of Communications and Multimedia Studies’ to create an interactive educational display game. A kiosk is being designed for the Ocean Discovery Center at FAU’s Harbor Branch Oceanographic Institute. The kiosk will create a hands-on experience which educates the public about future ocean energy projects. This effort will be leveraged to provide similar kiosks to science and discovery museums. The intent is to provide an opportunity to engage all ages in a hands-on, fun and educational experience about ocean renewable energy production. The kiosks will increase knowledge of real, cutting- edge research in renewable energy from the ocean as well as, incorporating valuable Science Technology Engineering & Math (STEM) content to inform the public.

The Center developed a curriculum for upper-division high-school students to introduce the topic within secondary education. An additional topic on policy and social interaction with renewable energy, with an emphasis on ocean energy, will be added this summer.

Over fifty upper-division graduates and Principle Investigators have been engaged in research in marine renewable energy (MRE) to date. Approximately a dozen of these students have secured positions in energy-related companies. One of the PhD students was selected as a Knauss Fellow after graduation and is currently serving in the U.S. Department of Energy’s





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Energy Efficiency and Renewable Energy focus in the Wind and Water Power Program. Partnerships between the SNMREC and the marine industry continue to expand.

More than 45 Non-Disclosure Agreements (NDA) have been signed with companies across the global marine industry. Language within the NDAs does not allow for the release of information of the details of the collaborations at this time. Industry sponsored funding is at a level of \$155,000.

Funding Leveraged

To date, with the State of Florida funding, the SNMREC has successfully leveraged \$5,455,675 of U.S. Department of Energy funds. DOE has identified an additional \$250,000 pending development of a Statement of Work and associated detailed budget against the current grant. Three proposals are in process and will be submitted in May and June.

