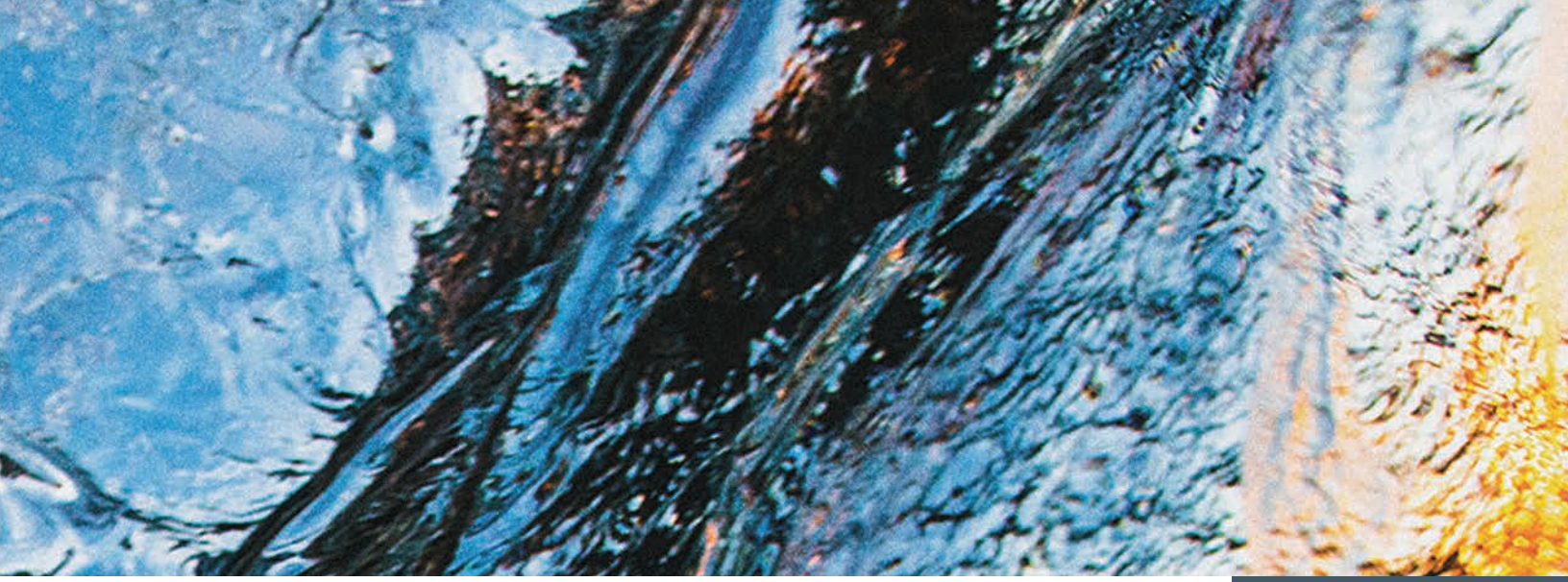

2017

Marine Energy Technologies Forum:
Distributed and Alternate Applications

U.S. DEPARTMENT OF
ENERGY

Office of
ENERGY EFFICIENCY &
RENEWABLE ENERGY

DECEMBER 5–7, 2017

THE ST. GREGORY HOTEL

WASHINGTON, D.C.

LETTER FROM THE DIRECTOR

Dear Forum Attendees,

On behalf of the U.S. Department of Energy Water Power Technologies Office (WPTO), I would like to welcome you to the **2017 Marine Energy Technologies Forum: Distributed and Alternate Applications**. We are eager to discuss additional marine energy applications that go beyond grid-connected utility-scale power and explore how emerging technologies that capture wave and tidal power can help meet the energy needs of a range of coastal and marine industries.

The forum's effort feeds into WPTO's core mission of advancing marine and hydrokinetic (MHK) technologies. By partnering with national laboratories, industry, and universities in research and development (R&D) focused on distributed and alternate applications and the specific R&D challenges they entail, we will further drive down the costs of wave and tidal systems and help ensure marine energy can provide a reliable, cost-effective source of energy to these industries and markets.

We are honored to host representatives from the MHK industry who are at the forefront of marine energy generation, as well as experts from high-potential markets. Most importantly, this is an opportunity for all attendees to provide individual feedback and input into which markets are best-suited to the different marine energy technologies and how devices can be designed and operated to maximize their benefits for each application. The forum will allow attendees to discuss and evaluate high-potential alternate markets for rapidly developing marine-energy technologies and support the Energy Department in aligning MHK technology research and development initiatives with high-priority opportunities.

It is our goal to provide you with an opportunity to network and engage in substantive dialogues with professionals from the MHK industry and national laboratories, gain a better understanding of the resources available to you, and provide information relevant to your needs and challenges so that we can work together to generate reliable and economical electricity from America's water resources. I appreciate your commitment in attending the forum and your dedication to shaping the future of the MHK industry.

Sincerely,

Alejandro Moreno

Tuesday, December 5, 2017	
7:15 a.m.–8:15 a.m.	**Networking Breakfast and Registration**
8:15 a.m.–8:25 a.m.	**Welcome to the MHK Distributed and Alternate Applications Forum** Speaker: Alexsandra Lemke, Senior Advisor, External Affairs, U.S. Department of Energy and National Renewable Energy Laboratory
8:25 a.m.–8:35 a.m.	**Opening Remarks** Speaker: Alex Fitzsimmons, Senior Advisor, Energy Efficiency and Renewable Energy
8:35 a.m.–8:45 a.m.	**U.S. Department of Energy MHK Program Overview** Speaker: Bill McShane, Technology Manager, U.S. Department of Energy, Water Power Technologies Office
8:45 a.m.–9:45 a.m.	**Exploring Potential for Micro/Macro Algae Markets** Speakers: • Perspective on Application Characteristics and Market Trends | Andrea Copping, Senior Program Manager, Pacific Northwest National Laboratory • Market Perspective | Marc von Keitz, Program Director, Advanced Research Projects Agency-Energy (ARPA-E) • Market Perspective | Devinn Lambert, Technology Manager, Bioenergy Technologies Office, U.S. Department of Energy • Market Perspective | Charles Yarish, Professor, University of Connecticut
9:45 a.m.–10:00 a.m.	**Networking Break**
10:00 a.m.–11:15 a.m.	**Case Study**
11:15 a.m.–12:15 p.m.	**Facilitated Discussion on the MHK Potential for Micro/Macro Algae Markets** Speaker: Facilitated Q&A | Anna West, Kearns & West
12:15 p.m.–1:15 p.m.	**Networking Lunch**
1:15 p.m.–2:15 p.m.	**Exploring Potential for Aquaculture Markets** Speakers: • Perspective on Application Characteristics and Market Trends | Andrea Copping, Senior Program Manager, Pacific Northwest National Laboratory • Market Perspective | Mark Rath, Science Coordinator, National Oceanic and Atmospheric Administration Office of Aquaculture • Market Perspective | Donna Lanzetta, CEO, Manna Fish Farms • Market Perspective | Clifford Goudey, Principle, C.A. Goudey & Associates • Market Perspective | Randall Brummett, Senior Specialist, World Bank
2:15 p.m.–2:30 p.m.	**Networking Break**
2:30 p.m.–3:45 p.m.	**Case Study**
3:45 p.m.–4:45 p.m.	**Facilitated Discussion on the MHK Potential for Aquaculture Markets** Speaker: Facilitated Q&A | Anna West, Kearns & West
4:45 p.m.–5:00 p.m	**Closing Session and Review** Speaker: Forum Summary | Bill McShane, Technology Manager, U.S. Department of Energy, Water Power Technologies Office
5:00 p.m.–7:00 p.m.	**No-Host Happy Hour**

DETAILED AGENDA (CONTINUED)

Wednesday, December 6, 2017	
7:15 a.m.–8:15 a.m.	**Networking Breakfast and Registration**
8:15 a.m.–8:20 a.m.	**Welcome** Speaker: Alejandro Moreno, Director, U.S. Department of Energy, Water Power Technologies Office
8:20 a.m.–8:30 a.m.	**Review of Previous Day and Introduction to Day 2 Topics** Speaker: Bill McShane, Technology Manager, U.S. Department of Energy, Water Power Technologies Office
8:30 a.m.–9:30 a.m.	**Exploring Potential for Ocean Observation / Navigation Aids Markets** Speakers: • Perspective on Application Characteristics and Market Trends | Al LiVecchi, Laboratory Program Manager, National Renewable Energy Laboratory • Market Perspective | Dana Manalang, Senior Engineer, University of Washington • Market Perspective | Andy Hamilton, Mechanical Engineering Group Lead, Monterey Bay Aquarium Research Institute • MHK Technology Developer Perspective | TBD
9:30 a.m.–9:50 a.m.	**Networking Break**
9:50 a.m.–11:05 a.m.	**Case Study**
11:05 a.m.–12:05 p.m.	**Facilitated Discussion on the MHK Potential for Ocean Observation / Navigation Aids Markets** Speaker: Facilitated Q&A | Anna West, Kearns & West
12:05 p.m.–1:05 p.m.	**Networking Lunch**
1:05 p.m.–2:05 p.m.	**Exploring Potential for Resident Autonomous Unmanned Vehicle (AUV)/Unmanned Underwater Vehicles (UUV) Recharging Markets** Speakers: • Perspective on Application Characteristics and Market Trends | David Hume, Marine Engineer, U.S. Department of Energy, Water Power Technologies Office • Market Perspective | Andy Stewart, Assistant Director, Defense & Industry Programs, University of Washington Applied Physics Laboratory • Market Perspective | CDR Andrew Gish, Assistant Professor, U.S. Naval Academy • MHK Technology Developer Perspective | TBD
2:05 p.m.–2:25 p.m.	**Networking Break**
2:25 p.m.–3:40 p.m.	**Case Study**
3:40 p.m.–4:45 p.m.	**Facilitated Discussion on the MHK Potential for Resident AUV/UUV Recharging Markets** Speaker: Facilitated Q&A | Anna West, Kearns & West
4:45 p.m.–5:00 p.m.	**Early Distributed Non-Grid Wind Power Technology Development; Parallels with Distributed and Alternate Markets for MHK** Speaker: Bob Thresher, Research Fellow, National Renewable Energy Laboratory
5:00 p.m.–5:10 p.m.	**Closing Session and Review** Speaker: Forum Summary | Bill McShane, Technology Manager, U.S. Department of Energy, Water Power Technologies Office
5:10 p.m.–7:00 p.m.	**No-Host Happy Hour**

Thursday, December 7, 2017

7:15 a.m.–8:15 a.m.	**Networking Breakfast and Registration**
8:15 a.m.–8:20 a.m.	**Welcome** Speaker: Alexsandra Lemke, Senior Advisor, External Affairs, U.S. Department of Energy and National Renewable Energy Laboratory
8:20 a.m.–8:30 a.m.	**Review of Previous Day and Introduction to Day 3 Topics** Speaker: Hoyt Battey, Market Acceleration and Deployment Program Manager, U.S. Department of Energy, Water Power Technologies Office
8:30 a.m.–9:30 a.m.	**Exploring Potential for Desalination of Seawater Markets** Speakers: • Perspective on Application Characteristics and Market Trends | Simon Gore, Environment and Policy Specialist, Water Power Technologies Office • Market Perspective | Tzahi Cath, Professor, Colorado School of Mines • Market Perspective | Paul Kelley, Executive Director, CalDesal • Market Perspective | Tom Pankratz, Editor, Water Desalination Report • Market Perspective | Saied Delagah, Chemical Engineer, U.S. Bureau of Reclamation • MHK Technology Developer Perspective | Bill Staby, CEO, Resolute Marine Energy
9:30 a.m.–9:50 a.m.	**Networking Break**
9:50 a.m.–11:05 a.m.	**Case Study**
11:05 a.m.–11:50 a.m.	**Facilitated Discussion on the MHK Potential for Desalination of Seawater Markets** Speaker: Facilitated Q&A | Anna West, Kearns & West
11:50 a.m.–12:50 p.m.	**Networking Lunch**
12:50 p.m.–1:50 p.m.	**Exploring Potential for Seawater Mineral Extraction Markets** Speakers: • Perspective on Application Characteristics and Market Trends | Andrea Copping, Senior Program Manager, Pacific Northwest National Laboratory • Market Perspective | Gary Gill, Technical Staff Member, Pacific Northwest National Laboratory • Market Perspective | Maha Haji, Mechanical Engineer, MIT • MHK Technology Developer Perspective | Elaine Buck, Technical Manager, European Marine Energy Center
1:50 p.m.–2:20 p.m.	**Networking Break**
2:20 p.m.–3:35 p.m.	**Case Study**
3:35 p.m.–4:20 p.m.	**Facilitated Discussion on the MHK Potential for Seawater Mineral Extraction Markets** Speaker: Facilitated Q&A | Anna West, Kearns & West
4:20 p.m.–4:50 p.m.	**Closing Session and Review** Speakers: Forum Summary | Bill McShane, Technology Manager, and Hoyt Battey, Market Acceleration and Deployment Program Manager, U.S. Department of Energy Water Power Technologies Office
4:50 p.m.–7:00 p.m.	**No-Host Happy Hour**

ABOUT US

The U.S. Department of Energy's (DOE's) WPTO advances cutting-edge technology with research and investments to modernize the U.S. hydropower fleet and drive U.S. leadership in marine energy, with the goal of delivering low-cost, reliable power and resiliency to the nation's electricity grids—which will benefit Americans from coast to coast.

WHAT WE DO

Leading the world in clean energy is critical to strengthening the American economy, and WPTO is at the forefront of the nation's clean energy frontier. The office works with national laboratories, industry, universities, and other federal agencies to conduct research and development activities through competitively selected, directly funded, and cost-shared projects. We are pioneering early-stage research and development efforts in marine and hydrokinetic technologies to improve performance, lower cost, and ultimately support the United States' ability to sustainably meet its growing energy demand.

WHY IT MATTERS

Our cutting-edge research portfolio is aimed to produce the next generation of water power technologies and jump-start private sector innovation critical to the country's long-term economic growth, energy security, and international competitiveness by accelerating the development of markets for those technologies.

TAPPING NEW SOURCES OF CLEAN, RENEWABLE ENERGY

MHK technologies convert the predictable and forecastable energy of waves, tides, and river and ocean currents into electricity and have the potential to provide millions of Americans with locally sourced, clean, and reliable energy. Additionally, MHK has the potential to provide cost-effective energy for numerous existing distributed and alternate applications in non-grid connected or remote, coastal areas—including military bases and smaller communities—where electricity costs are high. WPTO is investing in this new and innovative industry, a nascent technology sector that is an example of American ingenuity at its best, producing cutting-edge technologies that can contribute to our nation's energy independence.

ADDRESSING ENVIRONMENTAL AND REGULATORY CONCERNS

Minimizing environmental impacts and speeding the permitting process for marine and hydrokinetic devices requires proper project siting. The office funds assessments of the potential environmental impacts of device deployment, including navigational and competing-use impacts. WPTO is also creating guidelines to help device developers navigate the regulatory process.

Advancing the Growth of the U.S. Water Power Industry: Federal Incentives, Funding, and Partnership Opportunities

The Water Power Technologies Office provides information for researchers, developers, businesses, manufacturers, communities, and others seeking various types of federal assistance available for advancing water power projects. Below you will find the primary federal incentives for developing and investing in water power, resources for funding water power, and opportunities to partner with DOE and other federal agencies on efforts to move the U.S. water power industry forward.

DOE OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY (EERE)

Through funding opportunities offered by various office programs (including WPTO), EERE offers financial assistance to businesses, industry, universities, and other organizations to encourage the development and demonstration of renewable energy and energy efficiency technologies with the goal of increasing their adoption. *https://eere-exchange.energy.gov/Default.aspx*

DOE ADVANCED RESEARCH PROJECTS AGENCY-ENERGY (ARPA-E)

ARPA-E funds short-term, technology-focused, applied R&D aimed at creating real-world solutions to important problems in energy creation, distribution, and use. The agency's focus is advancing high-impact energy technologies that are too early for private-sector investment but have the potential to radically improve U.S. economic security, national security, and environmental well-being. *https://arpa-e.energy.gov/?q=programs/apply-for-funding*

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM

The Small Business Administration's SBIR program encourages U.S. small businesses to engage in federal R&D that has potential for commercialization. Its mission is to support scientific excellence and technological innovation through the investment of federal research funds in critical American priorities to build a strong national economy. Eleven federal agencies, including DOE, participate in the program, soliciting grant proposals from small businesses and making awards on a competitive basis. *https://science.energy.gov/sbir/funding-opportunities/*

DOE OFFICE OF TECHNOLOGY TRANSITIONS TECHNOLOGY COMMERCIALIZATION FUND (TCF)

The TCF leverages the R&D funding in DOE's applied energy programs to advance energy technologies with the potential for high impact. It uses 0.9% of the funding for DOE's applied energy research, development, demonstration, and commercial application budget for each fiscal year from the Office of Electricity, Office of Energy Efficiency and Renewable Energy, Office of Fossil Energy, and Office of Nuclear Energy. These funds are matched with funds from private partners to promote promising energy technologies with the goal of increasing the commercialization and economic impact of energy technologies developed at DOE's national labs. *https://energy.gov/technologytransitions/services/technology-commercialization-fund*

SMALL BUSINESS TECHNOLOGY TRANSFER (STTR) PROGRAM

The Small Business Administration's STTR program funds collaborative efforts between small businesses and research institutions with the goal of transferring technologies and products from the laboratory to the marketplace. STTR's focus is on bridging the gap between the performance of basic science and the commercialization of resulting innovations. Five federal agencies, including DOE, participate in the program, soliciting grant proposals from small businesses and making awards on a competitive basis. *https://science.energy.gov/sbir/*

SMALL BUSINESS VOUCHERS (SBV)

DOE's SBV program provides clean-energy small businesses access to select national labs—making the contracting process simple, lab practices transparent, and access to the labs' unique facilities practical. Through SBV, selected small businesses receive access to the state-of-the-art facilities and experts at participating DOE national labs, while the labs expand their knowledge of and involvement with the private sector, helping small businesses with advanced technologies contribute to American competitiveness and economic growth. *https://www.sbv.org/*

NATIONAL LABORATORIES WITH MARINE AND HYDROKINETIC EXPERTISE

Stemming from immense government investment in scientific research during World War II, DOE's national laboratories have served as the leading institutions for scientific innovation in the United States for more than 70 years. Today, 17 national laboratories address large-scale, complex research and development challenges with a multidisciplinary approach that translates basic science into innovation.

WPTO funds several national labs to conduct early-stage research to accelerate innovative water power technologies. The national labs also work with industry, academia, and many other stakeholders to solve scientific challenges while providing test facilities, sophisticated instrumentation, and deep expertise.

The following laboratories are working directly with DOE on specific activities concentrating on MHK research and development:

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

The National Renewable Energy Laboratory (NREL) is the only U.S. national laboratory solely dedicated to advancing renewable energy and energy efficiency. NREL's water program leverages decades of experience in wind energy, marine energy, and distributed and hybrid energy system research and development—along with a world-class laboratory validation infrastructure—to help increase performance and reliability and lower the cost of marine energy and hydropower technologies. NREL's water researchers apply expertise in numerical modeling, control systems, and electric and mechanical design to accelerate the development of robust and efficient MHK devices and components. NREL offers wave and tidal device modeling and design capabilities under both operational and extreme conditions utilizing a suite of NREL-developed codes, computational fluid dynamics, finite element structural analysis, and control system design tools. The lab also has a mechanical and electrical testing infrastructure ideal for validating and improving designs, assessing system integration, optimizing control systems, evaluating reliability, and characterizing and optimizing the system response under different grid conditions. NREL engineers have performed more than 200 full-scale field, structural, electrical, and drivetrain tests, and the Modular Ocean Instrumentation System can collect valuable open-water test data. For more information about NREL and how we can partner to solve key challenges, visit: *www.nrel.gov/water*

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Pacific Northwest
NATIONAL LABORATORY

Pacific Northwest National Laboratory's longstanding partnerships with Pacific Northwest industries, agencies, and MHK developers allow for collaboration, sharing of insights, and development of MHK technologies. The Marine Sciences Laboratory in Sequim, Washington—DOE's only coastal laboratory—provides researchers with a place to test and improve their technologies with support from world-class scientists, dive teams, research vessels, and lab facilities. Research at the Marine Sciences Laboratory advances the industry through projects that lower the cost of mineral extraction from seawater, increase the accuracy of marine energy resource characterization, reduce the impacts of biofouling, and improve environmental monitoring via new sensors and machine learning. These capabilities work together to reduce financial risk, inform device design, and guide siting to attain energy production goals. Pacific Northwest National Laboratory further contributes to the MHK community by gathering resources, managing data, and sharing information via the Tethys Knowledge Management System and participating in International Energy Agency Ocean Energy Systems information-sharing.
waterpower.pnnl.gov/mhk/

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Sandia National Laboratories

Sandia National Laboratories (Sandia) Water Power Technologies Program conducts applied research to improve the performance and reliability of MHK technologies, address environmental barriers, and characterize wave energy resources, all while lowering the cost of energy. Sandia's MHK research leverages decades of experience in engineering, design, and analysis of wind power technologies, and Sandia's vast research complex includes high-performance computing, advanced materials and coatings, nondestructive inspection, complex systems simulation, and large-scale testing. Research projects often involve highly collaborative partnerships between Sandia, industry, and academia to respond quickly to technical challenges with impactful results. MHK technology developments include current energy conversion devices—hydrokinetic turbines that extract power from water currents (riverine, tidal, and ocean)—and wave energy conversion devices that extract power from wave motion. Sandia develops open source codes for MHK device and array-scale design and analysis that are available for use and further development. Sandia also develops tools and strategies to monitor and mitigate effects of MHK devices to facilitate project permitting and reduce regulatory costs of deployment. Sandia leverages its deep technical background in the areas of robotics, advanced dynamics, and controls systems to maximize the performance of power takeoff hardware and software through its testing capabilities.
energy.sandia.gov/energy/renewable-energy/water-power/

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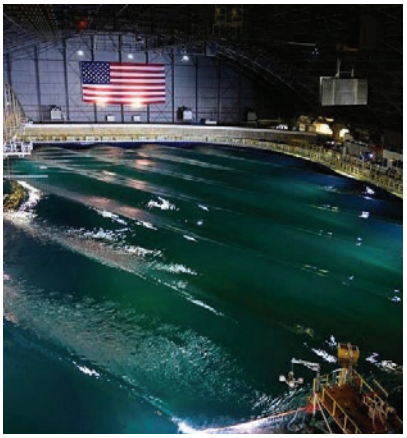
DOE SUPPORT OF NATIONAL MARINE ENERGY RESEARCH CENTERS AT U.S. UNIVERSITIES

As part of Congressional action establishing the Department's marine energy research program, DOE was directed to create and support a number of National Marine Renewable Energy Centers (NMRECs). Three of these centers were competitively selected and launched at U.S. universities in the Pacific Northwest, the Southeast, and in Hawaii, each with unique research and testing capabilities related to addressing the most pressing questions for new marine energy technology development.



Marine Energy Research Centers

HAWAII NATIONAL MARINE RENEWABLE ENERGY CENTER

A primary objective of the Hawaii National Marine Renewable Energy Center (HINMREC) is to facilitate the development of commercial wave energy systems. HINMREC assisted the U.S. Navy in the implementation of a grid-connected wave energy test site at Marine Corps Base Hawaii in Kaneohe. Its Wave Energy Test Site provides multiple-berthing for prototype wave energy conversion devices, which allows developers to prove their devices and generate the necessary data to advance their designs toward commercial readiness. Another objective of HINMREC is to assist the private sector in moving ocean thermal energy conversion systems beyond proof-of-concept to pre-commercialization. The technical role of the Center is primarily focused on system and component engineering and local and global environmental studies. HINMREC maintains high-resolution models of the ocean thermal resource and sustainable power output with ocean thermal energy conversion systems. Ongoing tests will be continued to identify aluminum alloys for use for devices operating in the corrosive marine environment.
hinmrec.hnei.hawaii.edu

NORTHWEST NATIONAL MARINE RENEWABLE ENERGY CENTER

The Northwest National Marine Renewable Energy Center's (NNMREC) mission is to facilitate commercialization of marine energy technology, inform regulatory and policy decisions, and close key gaps in scientific understanding with a focus on student growth and development. NNMREC works closely with a variety of stakeholders, including marine energy device developers, community members, ocean users, federal and state regulators, and government officials to conduct research on wave, tidal, in-river energy, and offshore wind technologies. NNMREC's project objectives include optimizing individual marine energy devices and arrays to increase their energy capture, improve their reliability, and decrease their cost of energy; evaluating potential environmental, ecosystem, and human-dimension interactions with marine energy technologies; facilitating and conducting research to inform adaptive management of marine energy technologies; improving forecasting, characterization, and assessment of marine energy resources; and, through the Pacific Marine Energy Center, developing integrated, standardized facilities to serve U.S. and international developers of wave, tidal, and in-river energy devices.
nnmrec.oregonstate.edu

SOUTHEAST NATIONAL MARINE RENEWABLE ENERGY CENTER

In working to fulfill its mission of advancing the science and technology of implementing marine renewable energy recovery, the Southeast National Marine Renewable Energy Center (SNMREC) has adopted a multiphase strategy. One of the core pieces within this strategy focuses on resource assessment, which includes oceanic measurements of the Florida Current and of the thermal resources offshore of southeast Florida. SNMREC also seeks to address testing infrastructure development, which is associated with the planning, fabrication, and deployment of equipment offshore to be used in at-sea tests of energy-generation prototypes. Environmental interactions research is another core component of the strategy, which includes a wide range of projects to develop understanding of the effects of the marine environment on marine renewable energy equipment and of the effects of that equipment, both at the prototype stage and for full-scale commercial deployments, on the marine environment. Outreach and education for the public are also key priorities.
snmrec.fau.edu

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The U.S. Department of Energy's Water Power Technologies Office is committed to developing and deploying a portfolio of innovative technologies and market solutions for clean, domestic power generation from water resources across the United States.

NOTES

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water.energy.gov
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