WATER POWER TECHNOLOGIES: CAPABILITIES & PRODUCTS

Enabling and supporting an emerging water power technologies portfolio including offshore wind, marine hydrokinetic, and conventional hydropower–through a systematic approach that develops and evaluates technology innovation and promotes environmental stewardship.

WATER POWER TECHNOLOGIES

Sandia National Laboratories conducts applied research to improve the performance and reliability of MHK technologies while lowering the cost of energy.

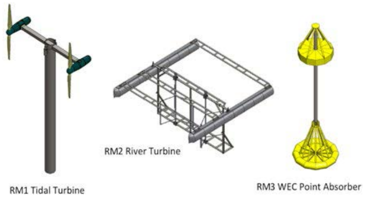
The MHK program draws on decades of wind power technology engineering and relies on Sandia's high performance computing and simulation, advanced materials and coatings, nondestructive inspection techniques, and large-scale testing capabilities. Research projects are often highly collaborative with partners in industry and academia.

ADVANCED WEC CONTROLS TESTBED

We are working to better understand the effects of advanced control on wave energy conversion (WEC) device performance. Our testbed combines computational modeling, control design, device fabrication, instrumentation, sensors, and large-scale model testing to support development and evaluation of control strategies that significantly improve WEC performance.

REFERENCE MODELS

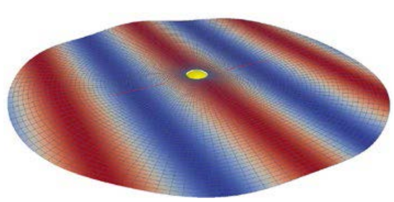
Sandia promotes open source MHK research and freely shares information about designs developed as performance and cost benchmarks. Learn more.



OPEN SOURCE CODE DEVELOPMENT

Sandia-developed codes for MHK device and array design can be publicly downloaded on GitHub and are available for further development by the open source community.

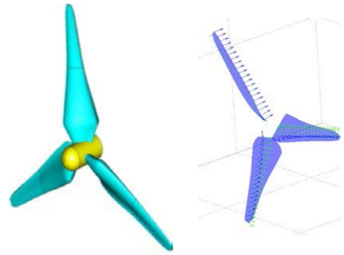
- WEC-Sim (Wave Energy Converter SIMulator) is an open source code developed by Sandia and the National Renewable Energy Laboratory to model WEC devices composed of rigid bodies, joints, power-take-offs, and moorings. WEC-Sim solves the governing equations of WEC motion in six degrees of freedom and simulates WEC performance in extreme conditions. Learn more.
- SNL-SWAN is an open source WEC array code modified from Delft University's SWAN (Simulating WAves Nearshore) to better account for WEC power performance and effects on the wave field. Learn more.
- CACTUS (Code for Axial and Cross-flow Turbine Simulation) is an open source, midfidelity simulation tool for quick analysis of design cases for axial-flow and cross-flow MHK turbines. Learn more.
- SNL-Delft3D-CEC combines and enhances two open source coastal circulation models to guide the design and layout of CEC arrays. This modeling framework simulates flows through and around a CEC array to maximize power production while minimizing environmental effects. For more, Learn more.
- An Extreme Conditions Modeling toolbox under development by researchers at Sandia and the National Renewable Energy Laboratory characterizes WEC design responses to extreme conditions. Learn more.



Linear and nonlinear potential flow modeling, with kinematics and full-system dynamics

TURBINE DESIGN

Sandia applies a variety of fluid and structural dynamics modeling tools to evaluate designs that minimize power performance losses from soiling/biofouling and reduce the likelihood of cavitation.



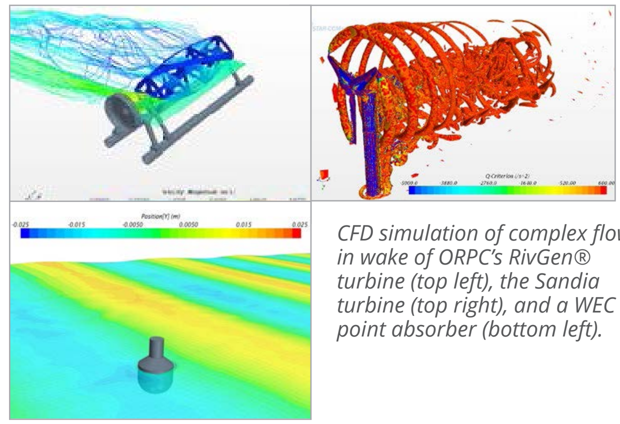
Design and analysis of the Sandia turbine using CACTUS and CFD models. Numerical models were validated with water tunnel experiments conducted at the Applied Physics Lab at Penn State.

DTOCEAN

Part of an international collaboration, the DTOcean software modules consider hydrodynamics, electrical systems, moorings and foundations, lifecycle logistics, controls, and maintenance.

HIGH PERFORMANCE COMPUTING

Sandia's high performance computing assets enable the use of computational fluid dynamics (CFD) models to analyze complex flow interactions and power performance for MHK designs and high-resolution wave model hindcasts for resource characterization.



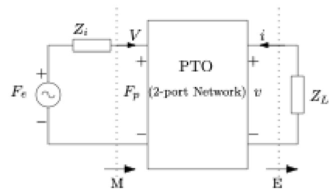
CFD simulation of complex flow in wake of ORPC's RivGen® turbine (top left), the Sandia turbine (top right), and a WEC point absorber (bottom left).

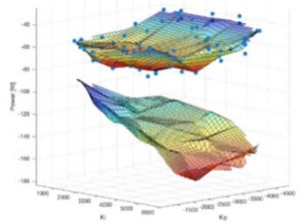
MATERIALS & NON-DESTRUCTIVE INSPECTION RESEARCH

Sandia research in advanced materials, coatings, adhesives, inspection techniques, and manufacturing processes can help produce reliable, cost-effective MHK devices.

CONTROLS & CO-DESIGN

Sandia supports parallel software and hardware development, known as co-design, which can increase power output by 200%. The optimal design for mechanical power is not the same as the optimal design for electrical power. By designing the control and system together, co-design maximizes power and minimizes costs. Impedance matching provides the framework. Without better power take-off (PTO) systems, the benefits of advanced control (100%+ more power) cannot be realized in terms of levelized cost of electricity (LCOE).



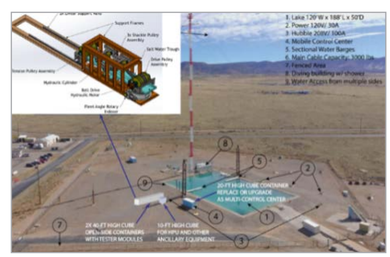


THE SANDIA WAVE ENERGY POWER TAKE-OFF (SWEPT) LAB

Designed specifically for testing WEC PTOs by control systems experts at Sandia, the SWEPT Lab adds value to researchers and industry by providing specialized methods and facilities for WEC PTO design and testing, including tests for internal power generating equipment for large-scale buoys and devices. The SWEPT Lab is a mobile system that can test wave energy power take-offs at the most convenient location.

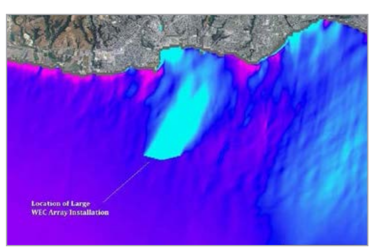
DROP TOWER COMPLEX

Sandia's Water Impact Complex offers a 120'W x 188'L x 50'D pool for testing full-scale and scaled wave energy devices as well as component testing of mooring lines, anchors, umbilical cables, acoustic doppler current profiler (sensors).



ENVIRONMENTAL ANALYSIS

Sandia develops tools and strategies to monitor and mitigate the environmental effects of MHK devices. Learn more.



RESOURCE CHARACTERIZATION

Sandia catalogues wave statistics for evaluating the power resources at wave sites and environmental loads on WEC designs. Learn more.

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Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525. SAND2024-00948M.