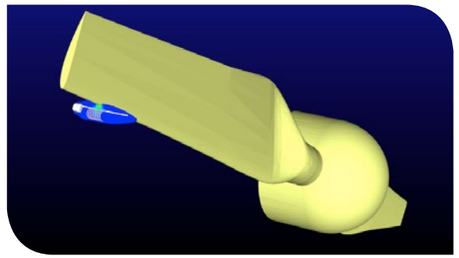
Strike Impacts to Sensitive Species

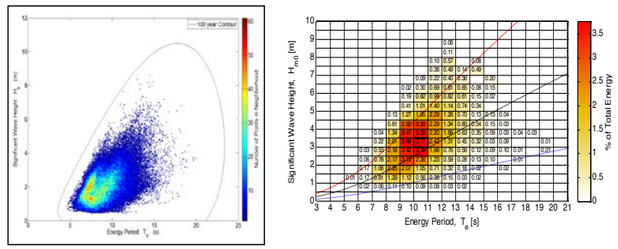
Sandia works collaboratively with Pacific Northwest National Laboratory (PNNL) to assess the biological consequence of collision between marine mammals with rotating tidal turbine components. Sandia uses its high-power computational platforms to simulate multiple collision scenarios to determine the impact stresses imparted on the anima. PNNL performs biological assessments to determine how the stresses affect the animals' wellbeing.



Cross section of a harbor seal collision with a large tidal turbine at time of impact.

Resource Characterization

Sandia catalogues critical wave statistics needed to determine the magnitude and quality of power resources at wave sites, as well as environmental loads required for WEC design.
energy.sandia.gov/energy/renewable-energy/water-power/resource-characterization/



Extreme sea state 100-year contour generated with improved I-FORM method developed by Sandia (left). Wave energy distribution among sea states at wave site (right).

For more information, please contact:

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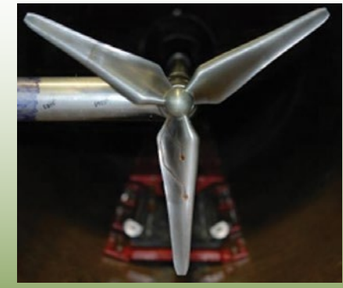
Water Power Technologies Department Mission

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

Water Power Technologies: Capabilities & Products

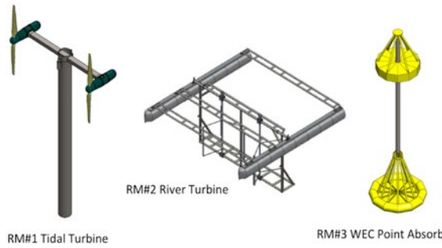


Sandia National Laboratories' (SNL) Water Power Technologies program conducts applied research to improve the performance and reliability of marine hydrokinetic (MHK) technologies while lowering the cost of energy.

MHK technology developments include current energy conversion (CEC) devices, for example, hydrokinetic turbines that extract power from water currents (riverine, tidal, and ocean) and wave energy conversion (WEC) devices that extract power from wave motion. Sandia's MHK research leverages decades of experience in engineering, design, and analysis of wind power technologies, and its vast research complex, including high-performance computing (HPC), 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 with impactful results.

Reference Model Development

To promote open-source MHK research, Sandia disseminates information on MHK technology point designs that were initially developed as reference models in partnership with other national laboratories to benchmark performance and costs. Open-source products, including a detailed methodology for the design and analysis of MHK devices, are available on the project's website:
energy.sandia.gov/rmp

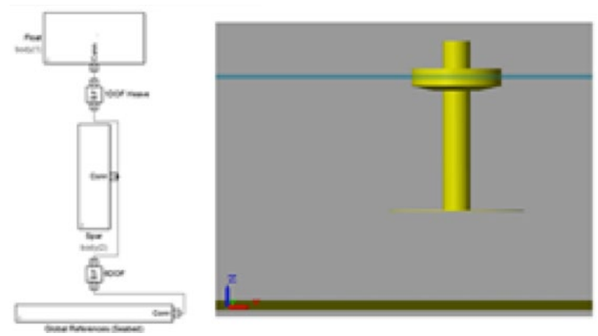


Open-Source Code Development

Sandia develops open-source codes for MHK device and array scale design and analysis. These open source codes are available publicly on GitHub online repositories for download and further development by the open source community.

WEC-Sim

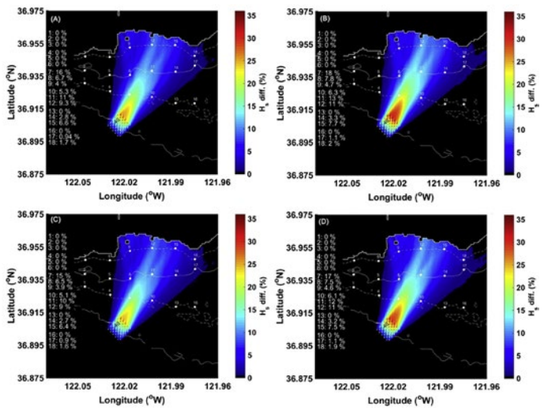
Wave Energy Converter SIMulator (WEC-Sim) is an open-source WEC code jointly developed by Sandia and the National Renewable Energy Laboratory. WEC-Sim models WECs composed of rigid bodies, joints, power-take-offs, and mooring. WEC-Sim solves the governing WEC equations of motion in six degrees-of-freedom and simulates WEC performance when it is subject to operational and extreme waves. For more about WEC-Sim, refer to its GitHub site: github.com/WEC-Sim/WEC-Sim



Application of WEC-Sim code to model RM3

SNL-SWAN

Sandia's Simulating WAves Nearshore (SNL-SWAN) is an open source WEC array code. Sandia modified the open source code, SWAN (Simulating WAves Nearshore), developed by Delft University of Technology, by adding a WEC Module to improve the way SWAN accounts for WEC power performance and effects on the wave field. For more on SNL-SWAN, refer to its GitHub site: github.com/SNL-WaterPower/SNL-SWAN



Application of the SNL-SWAN code to model a wave farm in Monterrey Bay

CACTUS

CACTUS (Code for Axial and Cross-flow TUrbine Simulation) is an open source simulation tool for design and analysis of axial-flow and cross-flow marine and hydrokinetic (MHK) turbines. As a mid-fidelity model, based on a free-vortex method, it allows quick analysis of a large number of design cases and inflow conditions. For more on CACTUS, refer to its GitHub site: github.com/SNL-WaterPower/CACTUS

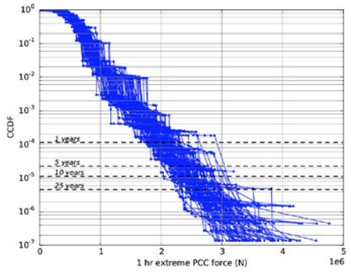
SNL-EFDC and SNL-Delft3D

Sandia has enhanced two open-source coastal circulation models to guide the design and layout of current energy converter (CEC) arrays to maximize power production while minimizing unwanted environmental effects. This modeling framework simulates flows through and around a CEC array while quantifying environmental responses.

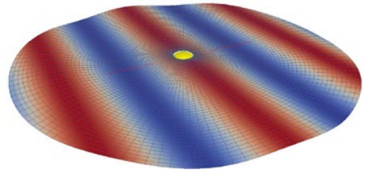
The SNL versions include a new module that simulates energy conversion by current energy converter (CEC) devices with commensurate changes to turbulent kinetic energy and its dissipation rate.

Extreme Conditions Modeling

Researchers at Sandia and the National Renewable Energy Laboratory are developing an extreme conditions modeling procedure to predict and characterize design responses and loads of WECs. These methods combine multi-fidelity modeling with advanced data analysis techniques, potentially decreasing uncertainty in design loads and improving structural efficiency and survival.



Replicates study to show variance in return level for extreme PCC force in a WEC

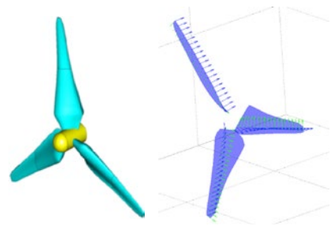


Linear and nonlinear potential flow modeling, with kinematics and full-system dynamics

Turbine Design

Leveraging Sandia's strong background in the design and analysis of wind-turbine rotors, Sandia applies a variety of fluid and structural dynamics modeling tools to design MHK turbines, including the Sandia turbine, developed to minimize power performance losses from soiling/biofouling, and reduces 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

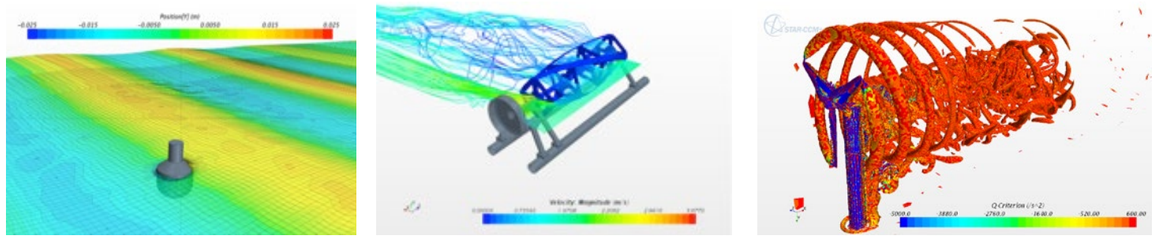
Sandia is the U.S. representative in the international DTOcean project that is developing open source design tools for deploying the first generation of wave and tidal energy converter arrays. The DTOcean software comprises several modules that consider hydrodynamics, electrical systems, moorings and foundations, lifecycle logistics, system controls, and operations and maintenance.

Advanced Wave Energy Converter Controls

Drawing on Sandia's experience and expertise, the Water Power Technologies department is working to better understand the effects of advanced control on WEC performance. Numerical modeling and control design are combined with large-scale model testing to provide industry with control strategies that improve performance.

High-Performance Computing

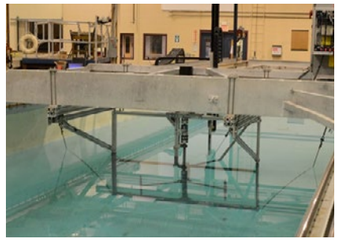
Sandia leverages its world-class HPC assets to advance MHK technologies using computational fluid dynamics (CFD) models to analyze complex flow interactions and power performance.



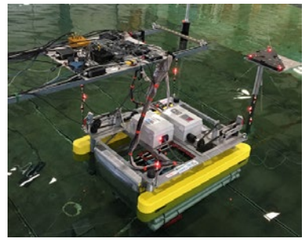
CFD simulation of complex flow in wake of ORPC's RivGen® turbine (left), the Sandia turbine (center), and a WEC point absorber (right).

Laboratory & Field Testing

Sandia conducts laboratory and field tests to evaluate the performance of MHK technologies and to validate and verify numerical models. Sandia also develops instrumentation systems and sensors to support laboratory and industry testing needs.



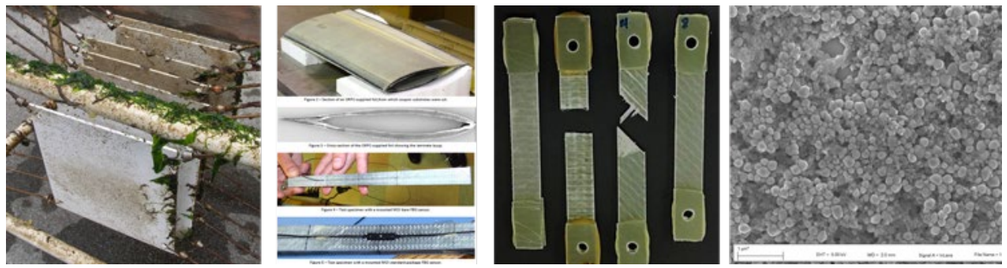
DOE Reference Model 2 turbine performance testing



WEC-Sim experimental validation testing of the floating oscillating surge WEC

Materials & Non-Destructive Inspection Research

Spanning the MHK and wind research areas, Sandia's Advanced Materials Program is dedicated to performing research in materials, coatings, adhesives, inspection, and manufacturing processes to produce reliable, cost-effective renewable-energy devices. Advances from Sandia's non-destructive inspection programs in Wind Energy and FAA Airworthiness Assurance NDI Validation Center are being applied to MHK.



Material Testing, left to right: biofouling & marine coatings assessment; monitoring component-material performance; marine effects on composite strength; nanomaterials.

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