

PROJECT SELECTIONS FOR MARINE AND HYDROKINETIC ENERGY TECHNOLOGY DEVELOPMENT

Discovery, Concept Definition, and Early Stage Development

- **Bayer Material Science LLC** (Pittsburgh, Pennsylvania) will analyze an innovative, non-turbine approach to harnessing river currents. The project will develop a new device called the Galloping Hydrokinetic Energy Extraction Device that will convert fast-moving river currents into an oscillating motion that will drive a dielectric elastomer generator (DEG). The DEG will generate electricity without the need for rotors or other moving parts. **DOE Funding: \$240,000. Total Project Value: \$686,000.**
- **Free Flow Energy, Inc.** (Lee, New Hampshire) will design and optimize a rugged submersible generator capable of coupling to a broad range of tidal and river current turbines, for use in a wide range of operational conditions. The goal is to develop an optimal generator for current energy conversion. **DOE Funding: \$160,000. Total Project Value: \$192,000.**
- **M3 Wave Energy Systems LLC** (Salem, Oregon) will explore the commercial viability of the submerged Delos-Reyes Morrow Pressure Device (DMP), an innovative air pressure device utilizing bi-directional turbines for converting ocean wave energy into electricity. The DMP design would be a fully submerged wave energy converter resting on the ocean floor, converting the oscillatory nature of a wave's pressure fluctuations into alternating compression and expansion cycles of flexible air-filled chambers that are connected to a bi-directional air turbine and an electrical generator. **DOE Funding: \$240,000. Total Project Value: \$300,000.**
- **Resolute Marine Energy, Inc.** (Boston, Massachusetts) will develop a cost-effective, high efficiency, power take-off system for a wave energy converter, a mechanism to convert water's mechanical energy into usable electricity. This is a unique approach that seeks to replace lower efficiency, high maintenance, long-stroke linear generator systems. The project will assess the cost of manufacturing these systems at various scales. **DOE Funding: \$160,000. Total Project Value: \$200,000.**
- **Semprus Biosciences** (Cambridge, Massachusetts) will develop an innovative, non-toxic surface coating that will prevent the growth of aquatic organisms on marine and hydrokinetic energy devices. This research into underwater coatings that prevent biofouling has the potential to positively impact all MHK systems and improve the conversion efficiency for MHK systems. **DOE Funding: \$160,000. Total Project Value: \$200,000.**
- **Shift Power Solutions, Inc.** (Encinitas, California) seeks to develop a technology that captures energy while doubling as a breakwater or embankment. This small-scale modular system will be designed to take the energy out of waves before they impact marine structures, while simultaneously generating electricity. Such a device offers the potential to significantly reduce construction costs and allow for generation equipment to remain dry. **DOE Funding: \$240,000. Total Project Value: \$391,000.**

- **Whitestone Power and Communications** (Delta Junction, Alaska) will conduct in-water testing and evaluation of a River In-Stream Energy Conversion (RISEC) device that has been designed to overcome the unique challenges presented by Alaskan river environments. The RISEC Project looks to redesign the undershot waterwheel turbine to improve survivability in areas with high aquatic life, debris, sediment loads, and extreme weather. The project will develop an innovative approach to harvesting hydrokinetic energy in the challenging environment of the Alaskan wilderness, with broader application to shallow streams throughout the United States and globally. **DOE Funding: \$142,000. Total Project Value: \$179,000.**
- **The Regents of the University of California** (Davis, California) will seek to develop an innovative, reliable, and cost-effective Bidirectional Rotor Tidal Turbine for tidal MHK applications. This innovative turbine could eliminate the need for blade pitching and rotor yaw controls, by using a bidirectional rotor tidal turbine that allows both flood and ebb currents to drive the rotor. Eliminating these subsystems reduces both capital and operations and maintenance costs and improves turbine reliability. This new rotor technology could reduce costs, improve reliability, and yield lower cost of energy than existing MHK configurations. **DOE Funding: \$158,000. Total Project Value: \$233,000.**
- **The Curators of the University of Missouri-Missouri S&T** (Rolla, Missouri) seeks to develop an active health monitoring system for MHK tidal turbines. An embedded fiber optic strain gage and acoustic transducer system will enhance component reliability by acquiring and transmitting data about turbine blades' structural health. Acoustic communication will be used to transmit strain gage data from the blade to the receiver station. Active health monitoring of components has been proven to reduce operations and maintenance costs and improve reliability in a wide range of other technologies and systems. **DOE Funding: \$160,000. Total Project Value: \$200,000.**

Component Proof-of-Concept

- **Atargis Energy, Inc.** (Pueblo, Colorado) will design, construct and test a laboratory-scale model of the Cycloidal Wave Energy Converter. This innovative device will be world's first free floating, fully submerged wave energy converter system that generates power from deep ocean waves by means of hydrofoil lift. **DOE Funding: \$400,000. Total Project Value: \$500,000.**
- **ORPC Alaska** (Anchorage, Alaska) will undertake an abrasion testing project that seeks to improve MHK designs for high sediment applications. The project will test critical components of hydrokinetic devices, such as bearings and seals, in waters with high levels of suspended sediment to assess the impact the sediment may have on system efficiency and functionality. ORPC will partner with the University of Alaska Anchorage (UAA) to test one-fifth scale bearings and seals of various types in laboratory-controlled, high suspended sediment conditions. This testing will produce rigorous data on bearing wear rates and seal performance over long-term operation, and the information gathered will apply both to tidal

and river applications in Alaska and across the U.S. **DOE Funding: \$240,000. Total Project Value: \$300,000.**

- **Sound & Sea Technology, Inc.** (Lynnwood, Washington) will develop engineering methods and best practices for developing more cost-effective and flexible anchoring technology. A remotely controlled grouting procedure suitable for deepwater anchor installations can help securely and cost-effectively anchor ocean energy devices to seabeds, while reducing the capital and installation costs of MHK systems. The team will test grout delivery in various situations and will monitor grout curing and final yield strength, for example, as methods for validating the grout delivery methods. **DOE Funding: \$239,900. Total Project Value: \$339,900.**
- **Sunlight Photonics, Inc.** (South Plainfield, New Jersey) will demonstrate an innovative tidal turbine system that incorporates a Hydraulic Energy Transfer system to pressurize and pump water to low-cost onshore hydroelectric generating stations. The system will employ tidal turbine blades to pressurize and push the water without using any underwater high-ratio gears or electrical components. **DOE Funding: \$400,000. Total Project Value: \$500,000.**
- **Turner Hunt Ocean Renewable LLC** (Cincinnati, Ohio) will demonstrate a breakthrough power control method that maximizes performance and power out of an ocean current turbine device. The project will test, demonstrate and validate THOR's Power Method that can provide dramatic increases to the capacity factor and output of ocean current turbines relative to existing MHK devices. The project proposes a method of operating a tethered ocean current turbine that uses a constant speed, variable depth control method, versus the conventional constant depth, variable speed method. **DOE Funding: \$400,000. Total Project Value: \$531,000.**
- **U.S. Synthetic Corporation** (Orem, Utah) will develop water-lubricated polycrystalline diamond thrust bearings (rotary bearings that allow device components to rotate under high axial loads) for use in marine and hydrokinetic energy devices; these bearings will help reduce operating costs, improve device reliability. The project results will help inform the MHK community to the advantages of an engineered material in bearings and other applications where hardness, thermal conductivity, strength, toughness, and abrasion resistance are required. **DOE Funding: \$147,000. Total Project Value: \$186,000.**

System Integration and Technology Laboratory Demonstration

- **Dehlsen Associates LLC** (Carpinteria, California) will develop the Aquantis C-Plane, an innovative turbine designed to extract kinetic energy from ocean currents. The project will test the C-Plane's patented passive depth stability (PDS), which balances positively and negatively buoyant forces acting on the system at prescribed operating depths. **DOE Funding: \$2,400,000. Total Project Value: \$4,000,000.**
- **Lockheed Martin MS2** (Manassas, Virginia) will validate the ability to numerically model the dynamic interactions between a large cold water pipe and a floating ocean thermal energy conversion platform in various meteorological and ocean conditions. The numerical

model will greatly reduce deployment risk and add to design surety for floating ocean thermal conversion platforms. **DOE Funding: \$600,000. Total Project Value: \$1,000,000.**

- **Makai Ocean Engineering, Inc.** (Kailua, Hawaii) will enhance a numerical model to quantify the relationships between ocean thermal energy conversion discharge component design, device performance, and environmental changes that may result from the discharge plume of ocean thermal energy conversion facilities. Developing the model will optimize system designs for ocean thermal energy conversion facilities in order to minimize potential environmental impacts. **DOE Funding: \$240,000. Total Project Value: \$337,000.**
- **Northwest Energy Innovations** (Portland, Oregon) will verify ocean wavelength performance for a new multimode floating point absorber wave energy device. The project will test the technology in targeted hydrodynamic testing in wave tank and controlled open sea settings. Northwest Energy Innovations is partnering with the National Marine Renewable Energy Center for the project. **Funding: \$1,818,500. Total Project Value: \$3,000,000.**
- **Ocean Power Technologies, Inc.** (Pennington, New Jersey) will create a fully integrated design for its 500 kilowatt PB500 PowerBuoy wave energy device. The project will quantify the operating characteristics of the PB500 design with computer simulations and 3D modeling and will modify the design to achieve target operating characteristics. The DOE funding is part of larger four-year project by the company that aims to manufacture commercially- available PB500s. **DOE Funding: \$2,400,000. Total Project Value: \$4,200,000.**
- **Princeton Power Systems, Inc.** (Princeton, New Jersey) will develop an innovative power conditioning system (equipment for improving the electrical output quality) with integrated energy storage that will improve marine and hydrokinetic device efficiency. Most MHK energy sources are variable and physically distant from load centers, requiring power conditioning systems that both “buffer” the power generation and transmit it to shore at high-voltage. This projects looks to develop a 50 kW Marine Power Conditioner with Storage that will demonstrate a high conversion efficiency and a compact high-frequency internal transformer to allow direct connection to a DC line for transmission to shore. The smaller size, higher efficiency, and simpler system design will significantly reduce the installation cost of ocean power systems while improving transmission efficiency and grid integration. **DOE Funding: \$600,000. Total Project Value: \$1,000,000.**
- **Scientific Solutions, Inc.** (Nashua, New Hampshire) will fully develop, integrate, test, and operate a full-scale active acoustic detection system for marine and hydrokinetic energy devices. This system will be deployed and integrated with ORPC’s TidGen™ prototype in Cobscook Bay, and will specifically monitor the region ahead of a tidal turbine for marine life and debris that may contact the device. This project seeks to have a complete acoustic monitoring system design, to have fully demonstrated the system in a prototype deployment that is integrated with an MHK system, and be able to make it commercially available to the MHK and offshore renewable power industry. **DOE Funding: \$600,000. Total Project Value: \$1,000,000.**

- **Vortex Hydro Energy LLC** (Ann Arbor, Michigan) will improve the efficiency of the power takeoff system in its VIVACE device, which generates electricity from vortex-induced vibrations created by water currents flowing over horizontal cylinders. Vortex Hydro Energy will focus on increasing the conversion efficiency from hydrokinetic energy to cylinder kinetic energy, as well as from the cylinder kinetic energy to electric energy generation, through laboratory tests to enhance hydrodynamic efficiency, construction and tow-tank testing of an enhanced power take off system, and open water testing of an integrated VIVACE prototype in Port Huron, MI. **DOE Funding: \$1,000,000. Total Project Value: \$1,673,000.**
- **Wavebob LLC** (Annapolis, Maryland) will develop and test an advanced power take-off (mechanical to electrical energy conversion) device for their point absorber wave generator, in preparation for a commercial-scale demonstration project planned for U.S. waters in 2013. Wavebob's WEC-1 System is an axisymmetric, self-reacting, oscillating point absorber designed to convert ocean wave energy to electricity. **DOE Funding: \$2,400,000. Total Project Value: \$4,700,000.**

Open Water System Testing, Demonstration, and Operation: System

- **Ocean Power Technologies, Inc.** (Pennington, New Jersey) will deploy a full-scale 150 kilowatt PowerBuoy system in the Oregon Territorial Sea and collect two years of detailed operating data. This project will obtain critical technical and cost performance data for one of the most advanced wave energy converters in the U.S. **DOE Funding: \$2,409,000. Total Project Value: \$4,809,000.**
- **Ocean Renewable Power Company** (Portland, Maine) will build, install, operate, and monitor a commercial-scale array of five grid-connected TidGen™ Project devices on the sea floor in Cobscook Bay off Eastport, Maine in two phases over three years. The project will advance ORPC's cross-flow turbine tidal energy technology, producing a full-scale, grid-connected energy system and will gather critical technical and cost performance data for one of the most advanced tidal energy systems in the U.S. The completed project will comprise an array of interconnected TidGen™ hydrokinetic energy conversion devices, associated power electronics, and interconnection equipment into a system fully capable of commercial operation in moderate to high velocity tidal currents in water depths of up to 150 feet. The project will significantly advance the technical, operational and environmental goals of the tidal energy industry at large. **DOE Funding: \$10,000,000. Total Project Value: \$21,100,000.**
- **Public Utility District No.1 of Snohomish County** (Everett, Washington) will deploy, operate, monitor, and evaluate two 10-meter diameter Open-Centre Turbines, developed and manufactured by OpenHydro Group Ltd, in Admiralty Inlet of Puget Sound. The project is expected to generate 1 megawatt (MW) of electrical energy during periods of peak tidal currents with an average energy output of approximately 100 kilowatts (kW). This full-scale, grid-connected tidal turbine system will gather critical technical and cost performance

data for one of the most advanced tidal turbine projects in the U.S. **DOE Funding: \$10,000,000. Total Project Value: \$20,100,000.**