Ocean Power Technologies:

Capturing Wave Energy for the U.S. Navy and the Grid

- **For Ocean Power Technologies (OPT), a competitive small-business grant award by the U.S. Navy in 1995 helped catalyze the development of wave energy conversion technology for Naval and civilian applications.**
- **Over the course of successive technology demonstration projects with the Navy, OPT has refined its PowerBuoy® technology for capturing the energy contained in the rise and fall of ocean waves.**
- **The PowerBuoy is now being applied to the powering of remote, ocean-based sensing equipment and other "power at sea" applications, and is being tested and scaled-up for grid-connected power generation in units as large as 500 kilowatts (kW).**

Quick Facts

Company Name:
Ocean Power Technologies

Company Website:
www.oceanpowertechnologies.com

Location:
Pennington, NJ (Headquarters)

Year Founded: 1994

Technology/Sector:
Wave Energy Conversion

2011 Revenue: $6.7 million

2011 Employees: 51

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A Wave Energy Company Finds Its Sea Legs

In 1995, the founders of Ocean Power Technologies (OPT), Dr. George W. Taylor and the late Dr. Joseph R. Burn, were venturing into waters previously uncharted by an American renewable energy company. Their vision centered on harnessing and converting wave energy into electricity for the grid using proprietary floating buoy technology, now called PowerBuoy. In its first year, the company focused on demonstrating the feasibility of its model buoys in wave tanks, with limited ocean testing off the coast of New Jersey, not far from its headquarters in Pennington. That same year, the U.S. Navy was investigating new ways to generate power from the ocean for remote sensing applications like floating radar and communication systems. The Office of Naval Research issued a Small Business Innovative Research (SBIR)[1] solicitation for demonstrations that marine energy could be used as a power source for these and other applications.

Although OPT's long-term goal is to develop technology for commercial-scale power generation "there was always a desire to provide our wave energy conversion technology to power remote sensing and communication equipment at sea," says Debbie Montagna, Vice President and General Manager of Government Systems for OPT. That interest, combined with the opportunity to refine its technology through focused research and development, convinced company leadership to apply to the Navy's competitive solicitation.

A Need to Demonstrate Continuous Progress in Wave Energy Technology

Wave energy conversion encompasses a range of technologies that are distinguished primarily by how they capture wave energy. OPT's PowerBuoy is one in a class of technologies called *point absorbers*. The principal behind the PowerBuoy is simple enough – a floating buoy is tethered to the seafloor and the rise and fall of the waves causes the floating portion of the buoy to move up and down. Beneath the floating section is a heavier segment that resists the movement of the waves. The relative motion between the two sections is converted via a "power take-off" device to drive an electrical generator. Sensors continuously monitor the performance of the various subsystems and surrounding ocean environment to optimize performance. Though based on simple concepts, wave energy conversion devices require robust designs and sophisticated controls to optimize performance and ensure reliability and survivability in the harsh ocean environment.

When OPT was awarded Phase I of the SBIR (primarily a paper study to determine the viability of the technology to address the Navy's problem statement) it signaled the beginning of a fruitful partnership between the company and the U.S. Navy that continues to this day. With the successful completion of Phase I, the Navy awarded a larger contract under Phase II to develop and test prototypes to meet the objectives of the SBIR. By 1997, after ramping up trials of several designs of its PowerBuoy and testing them in the Navy's wave tank facility and in the Atlantic Ocean, OPT demonstrated success against two important benchmarks: the buoy could operate for an extended period of time at sea (11 months) and it could endure harsh ocean conditions, including large waves, major storms and salt water.

Refining the PowerBuoy for Different Applications

Encouraged by the performance and survivability exhibited by the buoys during the Phase II program, in 2001, the Navy wanted to see if their electrical output could be increased sufficiently for utility power applications. Thus, the third and final phase of this particular SBIR program would enable OPT to put its initial vision—grid-connected PowerBuoys—to the test. Beginning in September 2001, OPT entered into a series of contracts with the Navy for the development and eventual deployment of additional wave power systems at the Marine Corps Base in Oahu, Hawaii,[2] an ideal proving ground for wave power generation because of the high cost of utility power in the area.

Three years after signing the first of these contracts with the Navy, OPT installed its first buoy—a unit with a peak production rating of 40 kilowatts (kW) of electrical power—in 100 feet of water, one mile off the coast of Oahu. This buoy met performance expectations and scored well in a rigorous environmental impact assessment that was necessary to proceed with the deployment of the buoy in Hawaii's Kaneohe Bay. Thus, the pieces appeared to be falling into place for producing utility-grade power from wave energy. "The Navy is pleased to see a technology that addresses a Department of Defense need also have such tremendous commercial potential. That's one of the main purposes of the SBIR program," remarked Vincent Schaper, who was the Program Manager at the Office of Naval Research in 2004.[3]

Over the next few years, OPT continued to develop its utility-scale wave power technology, and in 2007, the company

achieved a few important steps along the commercialization pathway. During that year, OPT's Undersea Substation Pod, the underwater system used to interconnect PowerBuoys to the grid, received an independent certification that it complied with national and international standards. Another focus was scaling the buoys themselves, and the company signed agreements to manufacture and install its new and larger 150 kW buoys for testing in Reedsport, Oregon, and in Scotland. The goal for the Reedsport project is to ultimately install 10 of these units, which will provide 1.5 megawatts (MW) of electricity to the grid. The company also filed for permits from the U.S. Federal Energy Regulatory Commission (FERC) to build two utility-scale power generation projects, one of 50 MW and the other of 100 MW, off the coast of Oregon. Wave power projects of this size had not been attempted previously in the United States.

Image courtesy of Ocean Power Technologies.

It turned out that 2007 was also an important year in other ways for OPT. Early in the year, the company raised $90 million in an Initial Public Offering (IPO) on the NASDAQ exchange.[4] Development work on PowerBuoys for remote-sensing applications also took a step forward as OPT began new SBIR work. The objective for this effort was to test a buoy off the coast of New Jersey to see if it could serve as a power source for the Navy's Deep Water Active Detection System, an ocean data-gathering and communications program.

Since 2007, OPT has continued to expand its work across a number of PowerBuoy applications. The Navy and OPT have continued to pursue "persistent power at sea for port maritime surveillance in the near coast, harbor, piers and offshore areas" through a program called Littoral Expeditionary Autonomous PowerBuoy ("LEAP"), a surveillance and security collaboration with Rutgers University. In September 2010, after more than 3 million power take-off cycles and 4,400 hours of operation, the 40 kW PowerBuoy in Hawaii was interconnected to the electrical grid for the first time at the Marine Corps Base Hawaii.[5] In that same month, the U.S. Department of Energy chose OPT from a field of competitors to test and ultimately manufacture larger buoys (500 kW) with the goal of developing a buoy of sufficient scale for commercially competitive power generation.[6] In the spring of 2011, the 150 kW unit built in Scotland began ocean trials. Construction of the first 150 kW unit in Oregon is likely to be completed in mid-2012. Meanwhile, OPT also has plans for wave power stations to be installed in Australia, England and Spain.

From Military Application to Commercialization

Developing a new technology takes time and perseverance, and entails considerable risk. The decision by OPT to apply for the initial SBIR grant in 1995 and the selection of the company by the U.S. Navy's Office of Naval Research has ultimately led to a series of important advances in wave energy conversion over the course of 15 years. The Navy has found a technology that can meet many of its needs for power-at-sea applications, including remote, ocean-borne monitoring and communication equipment, and can envision new possibilities, such as ocean observing and remote charging stations for autonomous underwater vehicles. Beyond these technological advances, the Navy has decided to establish a wave energy test center at Marine Corps Base Hawaii, which will be open to all ocean-energy technology developers starting in 2012.

In the process of developing these solutions for the Navy, OPT has developed new technologies and identified new markets.

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>
> *Vincent Schaper*
> *Program Manager at the Office of Naval Research (2004)*

For power-at-sea applications, the company's PowerBuoy is "ready for commercialization now," according to Bob Lurie, Vice President of North America Business Development. So ultimately, the company has also made significant progress toward its long-term vision of utility-scale wave power, and achieving a globally competitive position with other companies trying to do the same.

Endnotes

1. Read more about the Small Business Innovative Research program (SBIR) at www.sbir.gov/about/about-sbir.

2. "Annual Report for the Year Ended April 20, 2011," Ocean Power Technologies, http://phx.corporate-ir.net/phoenix.zhtml?c=155437&p=irol-IRHome (December 23, 2011).

3. "Ocean Power Technologies Awarded Contract to Provide Wave Energy System to Lockheed Martin," Ocean Power Technologies press release, May 19, 2004, http://phx.corporate-ir.net/phoenix.zhtml?c=155437&p=irol-newsArticle&ID=989924&highlight= (December 23, 2011).

4. "Annual Report for the Year Ended April 20, 2011," Ocean Power Technologies (December 23, 2011).

5. "Waves Power US Grid for the First Time," Renewable Energy World, September 28, 2010, www.renewableenergyworld.com/rea/news/article/2010/09/waves-power-us-grid-for-the-first-time (December 22, 2011).

6. Gruen, Abby, "Ocean Power Technology wins $4.8 M from DOE for wave energy system," The Star Ledger, September 13, 2010, www.nj.com/business/index.ssf/2010/09/ocean_power_technology_of_penn.html (December 28, 2011).