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I. Introduction to Wave Energy Opportunities and Developments

Mr. Chairman, Members of the Committee, and Congresswoman Hooley in particular, thank you for inviting me to testify today before this Subcommittee. I am Annette von Jouanne and I am a Professor of Power Electronics and Energy Systems at Oregon State University. I am honored to testify before you today on the subject of Ocean Wave Energy.

Ocean energy exists in the forms of wave, tidal, marine currents (from tidal flow streams), thermal (temperature gradient) and salinity. Among these forms, significant opportunities and benefits have been identified in the area of wave energy extraction, which will be the focus of this testimony.

When we discuss Wave Energy, we are talking about harnessing the linear motion of the ocean waves, and converting that motion into electrical energy. Waves have several advantages over other forms of renewable energy, in that the waves are more available (seasonal, but more constant) and more predictable with better demand matching. Wave energy also offers higher energy densities, enabling devices to extract more power from a smaller volume at consequent lower costs and reduced visual impact.

Oregon State University (OSU) has a multidisciplinary Wave Energy Team pursuing developments in four thrust areas: 1) researching novel direct-drive wave energy generators (we are on our 5^{th} and 6^{th} prototypes, with further wave lab and ocean testing planned this summer), 2) developing an action plan for a National Wave Energy Research and Demonstration Center in Oregon, 3) working closely with the Oregon Department of Energy (ODOE) and a variety of stakeholders to promote Oregon as the optimal location for the nation's first commercial wave parks, and 4) examining the biological and ecosystem effects of wave energy systems.

II. Current Ocean Wave Energy Research, Development and Investment Activities

OSU's direct-drive wave energy buoy research focuses on a simplification of processes, i.e. replacing systems employing intermediate hydraulics or pneumatics with direct-drive approaches to allow generators to respond directly to the movement of the ocean by employing magnetic fields for contact-less mechanical energy transmission, and power electronics for efficient electrical energy extraction. The term "direct" drive describes the direct coupling of the buoy's velocity and force to the generator without the use of hydraulic fluid or air.

Leading Wave Energy companies, such as Ocean Power Technologies (OPT), Finavera Renewables, Ocean Power Delivery (OPD) and Oceanlinx, are using hydraulic and pneumatic technologies, because it makes sense for a company trying to accelerate their time to a commercial market to use more mature technologies. In the university environment, as we are working with students on advanced degrees, we endeavor to explore innovative and advanced technologies.

Wave energy developments in the United States are moving forward rapidly, with twelve (12) preliminary permits filed with FERC (Federal Energy Regulatory Commission) for off the West Coast (see Attachment 1). The first commercial wave energy device deployments are planned by

the summer of 2008. Remaining obstacles include issues of survivability, reliability, maintainability, cost reduction, better understanding of potential environmental/marine impacts and synergistic ocean community interaction with wave parks. OSU has made great efforts over the past nine (9) years to develop a leading Wave Energy program, including building strong support at the state and federal levels, in addition to building essential collaborations with industries, utilities and the communities along with outreach to the ocean community of fishermen and crabbers etc.

III. The Federal Role in Ocean Wave Energy Research and Development

Currently there has been very little investment by the Federal Government compared to the rest of the world, and thus as occurred similarly in the wind industry, the United States is lagging behind other countries in the development of wave energy technologies. For the United States to become a wave energy leader in what is projected to become a rapidly developing new set of industries, the Federal Government needs to significantly increase their investment in wave energy research and development.

It has been reported that since 1999, the British government has committed more than £25 million, or approximately $46.7 million, to research and development and £50 million to commercialize that research, and additional money to bring the energy into the electrical grid. In August of 2004, a £5.5 million ($10.72 million) European Marine Energy Center opened in Scotland. To date, the United State has no comparable facility.

Ideally, we believe the US Department of Energy, the Office of Naval Research, and the National Oceanographic and Atmospheric Administration (NOAA) should all begin investing in Ocean Wave Energy research. However, we believe it is imperative for the US Department of Energy to become the leader in this field and to begin making a robust investment in Wave Energy research. As DOE's National Renewable Energy Laboratory (NREL) is charged with leading the nation in renewable energy and energy efficiency research and development, it is our belief that NREL should establish a unit dedicated to ocean wave energy research.

Along these lines, the combination of key facilities at OSU, ongoing successful wave energy research and collaboration, and a tremendous wave climate off the Oregon coast has led to the proposal of a National Wave Energy Research and Development Center. In order to ensure U.S. leadership in what will become a multi-million dollar industry worldwide (multi-"billion" dollar as the wind industry is tracked), the Center could advance wave energy developments through a number of initiatives including: explore and compare existing ocean energy extraction technologies, research and develop advanced systems, investigate efficient and reliable integration with the utility grid and intermittency issues, advancement of wave forecasting technologies, conduct experimental and numerical modeling for device and wave park array optimization, develop a framework for understanding and evaluating potential environmental and ecosystem impacts of wave energy, establish protocols for how the ocean community best interacts with wave energy devices/parks, develop wave energy power measurement standards, determine wave energy device identification/navigation standards etc.

The Oregon Coast has an excellent Wave Energy climate, and combined with our strategic facilities at Oregon State University, Oregon is in an excellent position to advance Wave Energy research, development and production. For example, at OSU, we have the highest power Energy Systems lab in any university in the nation, where we have conducted significant work in renewables, and where we can fully regenerate back on to the grid to comprehensively research and test renewable energy technologies. In addition, at OSU we have the O.H. Hinsdale Wave Research Lab, which has the largest system of wave basins in North America. At the coast in Newport, Oregon, we have the OSU Hatfield Marine Science Center, where land-based facilities

for a National Wave Energy Research and Demonstration Center could be integrated. The OSU Hatfield Marine Science Center campus is already home to satellite labs and offices for a number of federal agencies— the US Fish and Wildlife Service, NOAA, EPA, and USDA-ARS.

To properly explore these Wave Energy opportunities, we have been working closely with Oregon Department of Energy (ODOE) and about 40 other agencies, including the Oregon fishing and crabbing industries, to enable the Nation's first Commercial Wave Parks to be developed off the Oregon Coast.

IV. Other Issues and Conclusion

As mentioned above, a significant barrier to wave energy development is the above-market cost of the electricity. Due to the early stage of this industry, the current cost of electricity production from waves is estimated to be several times the market price, similar to wind when it was emerging 20 years ago. To ensure the success of wave energy as a promising renewable contribution to the nation's energy portfolio, the production incentive is very important to offset the above-market costs of producing 'wave' generated electricity. At the federal level, it is critical that wave energy receive a similar incentive mechanism to the production tax credits that the wind industry receives.

As the nation tries to meet its renewable energy goals, ocean wave energy must be a part of the portfolio. Given that approximately fifty percent of the US population lives within fifty miles of the US coastline, we must invest in making ocean energy viable—this cannot be done without the robust support of the federal government's research agencies.

In the state of Oregon we are very excited to be a leader in wave energy development. We have the wave resource, the expertise through collaboration including tremendous industry, utility and community support, and the utility infrastructure along the coast to deliver this clean, renewable power into the grid.

Thank you for the opportunity to testify before this esteemed Subcommittee.

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Attachment 1

Wave Energy preliminary permits filed with FERC