Written Statement of

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Of the Committee on Science, Space and Technology
U.S. House of Representatives

"Marine Energy: The opportunity and benefits of U.S. leadership"

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Chairman Lamb and Ranking Member Weber, thank you for the opportunity to testify today on the untapped potential of our U.S. marine energy resource, the value propositions for marine energy, the opportunity for U.S. leadership, and how the *Water Power Research and Development Act of 2019* is of utmost importance for domestic capture of this emerging, multibillion-dollar sector.

I am a co-Director of the Pacific Marine Energy Center (PMEC) and an Associate Professor in Civil Engineering at Oregon State University. I have spent the better portion of the past 20 years actively involved within the North American marine energy market, energy systems and coastal engineering sectors. From helping design the hybrid renewable energy system for the Race Rocks, the first tidal energy turbine deployed in North America (2004), to my current role in PMEC, my involvement has included conducting fundamental research within universities, developing commercial products within industry, and helping government organizations develop implementation roadmaps for marine energy commercialization. My research and professional portfolio covers the full development cycle for marine energy systems with expertise that includes resource assessments, to technology development, to market opportunity evaluations. I have worked with large multinational corporations, small technology developers, private NGO's, tribes, large electrical utilities, and international information technology companies to better understand their roles and opportunities in this emerging sector. Additionally, my research efforts also include long-term electricity system transition analyses. As our electricity systems rapidly evolve, it is imperative that we understand the opportunities and challenges at the nexus of global economic growth, climate change, renewable technology development, policy ambitions, and human social structures.

Overview

This testimony provides an overview of the marine energy opportunity, the strategic advantages associated with the U.S. effort, the renewable energy funding landscape, and a clear vision of the value proposition for the *Water Power Research and Development Act of 2019*.

The Pacific Marine Energy Center (PMEC) is a competitively designated U.S. Department of Energy (DOE) Center focused on the responsible advancement of marine energy by expanding scientific understanding, engaging stakeholders, and educating students. Within PMEC, researchers from Oregon State University, the University of Washington, and the University of Alaska Fairbanks work closely with marine energy technology developers, academic and National Laboratory researchers, coastal community members, ocean users, federal and state regulators, and other government officials, to address key challenges in the sector and

accelerate its emergence. Our mission is to serve as an objective voice regarding the opportunities, capabilities, and effects of marine energy, including wave, tidal, riverine, and offshore wind resources.

Marine Energy Resources and Opportunities

Marine energy is one of the last significant untapped renewable resources.

Marine energy encompasses energy in waves, tides, currents, rivers, salinity and temperature differentials. As shown in Figure 1, recent resource assessments quantify the U.S. wave resource as upwards of 3500 TWh, the tidal resource as 450 TWh, the ocean current as approximately 200TWh, and the river resource as 130TWh. To provide some context, the current U.S. electricity demand is approximately 4100 TWh. As such, marine energy has the potential to provide significant and needed renewable electricity resources to the U.S. grid – resources which will compliment the suite of other renewable energy resources currently helping drive our transition from fossil fuels to renewable electricity generation.

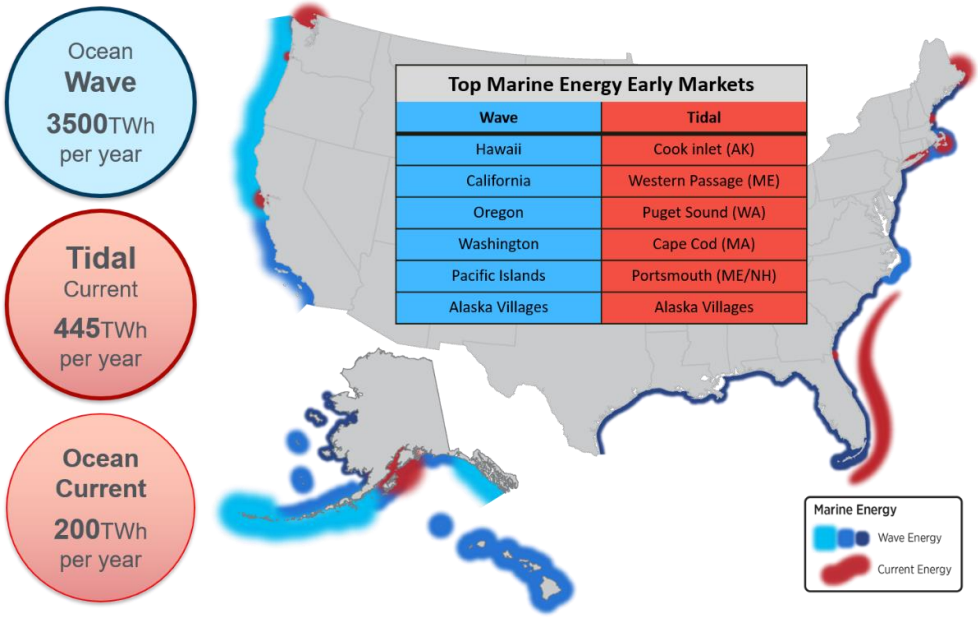

Figure 1: U.S. Marine Energy Resources (U.S. DOE National Renewable Energy Laboratory)

In addition to its potential as an immense raw resource, marine energy offers a suite of additional ancillary benefits to the utility electricity markets. These include location, forecastability and availability, to name just a few. Coastal counties of the U.S. are home to over 126 million people, or 40 percent of the nation's total population. If these counties aggregated their GDP, it would rank third in the world – behind only the U.S. and China. As such, the electricity demands of our coastal region is massive and rapidly increasing. The ability to transmit electricity vast distances from remote electricity generation facilities is becoming increasingly expensive, socially unacceptable, and susceptible to climate-related changes (e.g., California wildfires and the relationship with the electricity system). Marine energy resources are the most proximate renewable resources to these growing coastal electricity demands and will play an important role helping reduce electricity-related emissions while improving the electrical system resilience. In terms of forecastablity, the fundamental physics behind the ebb and flow of marine energy resources is well understood, allowing for system operators and project developers to accurately forecast the future power generation – a high value benefit when trying to manage a dynamic and increasingly variable electricity system. Finally, for many locations, the seasonal availability of marine energy resources correlates with the demand for electricity – thus minimizing the need to back-up fossil fueled generation or large-scale energy storage systems.

Last year alone, the renewable energy market saw investments of $280B – far exceeding fossil fuel investments. As global markets and electricity utility policies drive towards increasing penetrations of renewable electricity, the need for new renewable electricity generating resources (beyond wind and solar) is creating significant economic opportunities for supportive countries, marine energy technology development companies, and research enterprises.

The U.S. Competitive Strategy and Advantage

The development of marine energy technologies is a challenge. The commercialization pathway takes longer and costs more than terrestrial renewable energy technology development – this is an inconvenient fact. As such, the commercial progress of marine energy companies has been slower than our wind and solar counterparts. However, the technology performance improvements and cost reductions clearly illustrate that marine energy is following the same dramatic cost reduction trajectory as both of these complimentary renewable resources.

In addition, and contrary to our wind and solar counterparts, marine energy inherently includes a number of competitive advantages and opportunities within the emerging 'Blue Economy'. According to the *Organization for Economic Co-operation and Development's* 2016 report, 'Blue Economy'-related industries and activities contribute more than $1.5 trillion in value added to the economy each year, and that value is expected to double by 2030. Marine energy is part of this economy, but also plays a linchpin role in providing the necessary power for much of the innovation space in the Blue Economy. Marine energy has the potential to enable entirely new sectors of offshore economic activity that are impossible today due to lack of reliable electricity in the open ocean.

Through extensive consultation within the U.S. marine energy and maritime sectors, the U.S. Department of Energy's Water Power Technologies Office (WPTO) recently released its '*Powering the Blue Economy*' initiative; which details specific, near-term market opportunities for marine energy. These include powering oceanographic measurement devices, recharging Underwater Autonomous Vehicles (UAV), renewably powering offshore aquaculture facilities, desalinating water, and powering remote isolated communities, amongst others (see Figure 2).

Figure 2: Powering the Blue Economy Sectors (WPTO)

By widening the aperture for marine-energy commercialization markets, the WPTO has shown international leadership – leadership which many of our international peers are now following. The *Powering the Blue Economy* initiative will allow U.S.-based technology developers to develop smaller marine energy devices, at lower per-unit-costs, and find commercial success faster; while concurrently building new capacities for remote observation and surveillance, providing clean drinking water, and mitigating energy poverty in isolated communities.

The '*Powering the Blue Economy*' initiative clearly illustrates the wide spectrum of commercial opportunities available for marine energy clean tech development – many of which are along the development trajectory to utility-scale power generation. The leadership shown by our colleagues within the WPTO has provided the U.S. with a clear opportunity to maintain global leadership, and a pathway to better utilizing our marine energy resources.

Federal Renewable Energy Investment

Thanks to the efforts of Congress over the past several years, the U.S. is beginning to make significant investments in marine energy technology development through the DOE WPTO. However, there is stiff international competition and other nations are actively seeking to capture this projected $61.8B per annum market (2050). The EU and Canada invest approximately $300M per year in marine energy, China invests approximately $150M per year, and Australia recently announced a $330M investment in marine energy and associated Blue Economy initiatives. Sustained and increased U.S. investment to optimize the domestic innovation and development potential for marine energy technology is critical to support U.S. leadership and market capture in this space.

The global marine energy industry is still widely dispersed around the world. Unlike our wind and solar peers, the U.S. still has the opportunity to ensure that technology development and associated economic benefits occur here rather than the U.S. simply being a user of other nations' technology. However, in order to achieve this objective and capture the benefits, the level of federal investment in early stage marine energy technology innovation must increase in-line with comparative early stage investment in renewable energy sector peers that effectively contributed to commercial viability. As shown in Figure 3, water power (marine energy & hydropower) funding has consistently been 3 to 4 times lower than wind and solar – despite marine energy representing early stage technologies where federal investment has the greatest opportunity to spur innovation and associated economic growth.

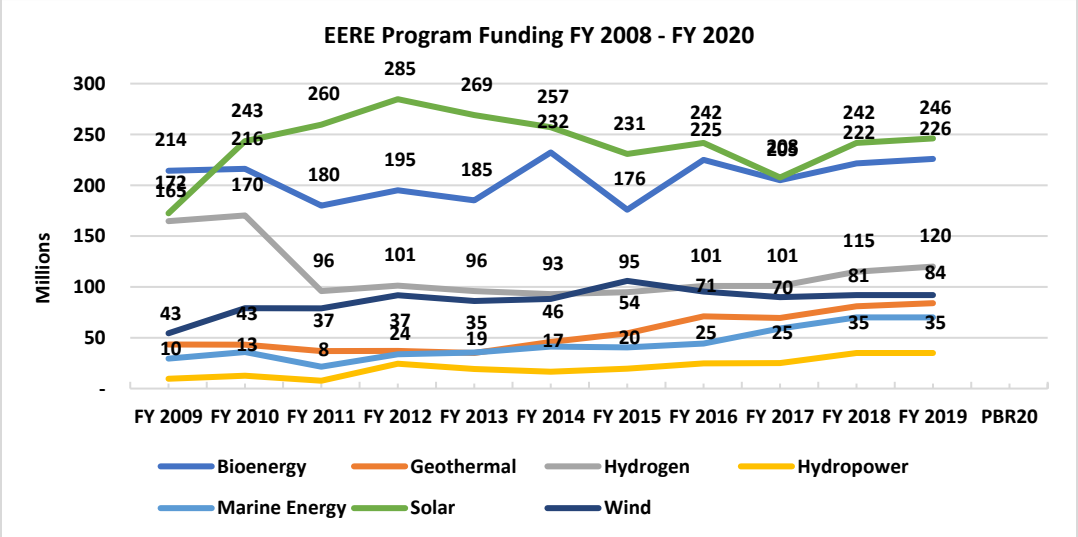

Figure 3: DOE EERE Renewable Program Funding History

The Pacific Marine Energy Center and Building an Industry

PMEC is globally recognized for our holistic view of the development pathway for marine energy. This pathway includes playing an integral role in the development of innovative technologies, but also developing a fundamental understanding of the environmental and social opportunities and challenges.

Through our Industry Partner Network (IPN), industry is able to work closely with PMEC affiliated faculty and students to leverage the wealth of knowledge and expertise within the academic institutions to accelerate development. As an example of PMEC-Industry collaboration, the Ocean Energy buoy currently on route for deployment in Hawaii was initially tested at small scale in the PMEC-Affiliated O.H. Hinsdale Wave Research Laboratory at OSU, numerical modelling by OSU Faculty, and will host the next generation of the PMEC Adaptable Monitoring Package (AMP) from the University of Washington during its' testing at the U.S. Navy's Wave Energy Test Site at Marine Corps Hawaii.

Additionally, PMEC-affiliated faculty and students understand the development of projects and industry require more than just technologies. We have active projects completing the most comprehensive environmental baseline analyses possible; which includes benthic species, transitory ocean mammals, sediment samples, and high-value fisheries. These efforts are paramount to ensure regulatory and permitting agents have all the necessary data to make evidence-based decisions for future projects. Additionally, PMEC at Oregon State University conducts rigorous outreach and engagement activities to identify the human dimensions and social constructs which would impact or accelerate future development.

The Water Power Research and Development Act of 2019

The *Water Power Research and Development Act of 2019* is essential to providing the sustained funding necessary to accelerate the development of this industry, ensure the U.S. leadership position, and support the wider spectrum of opportunities to allow marine energy technologies to provide disruptive solutions to the multibillion-dollar Blue Economy. Unlike wind and solar, marine energy technology developers do not currently benefit from any tax support mechanisms such as the Investment Tax Credit (ITC) or the Production Tax Credit (PTC). Funding from the DOE WPTO is the key (and only) mechanism to support U.S. technology developers competing against overseas companies that receive a suite of subsidies.

By investing in a marine energy focused program at DOE, comparable especially to our solar peers, we can grow a marine energy industry that will provide new economic opportunities, high wage jobs, a clean energy source to coastal communities, and a new understanding of our oceans.

The Next Generation

As a faculty member at an institution of higher education, I would be remiss if I did not close by focusing on the urgent need to educate and train the next generation of energy leaders and maritime innovators. As the world becomes increasingly interconnected and resource stressed, it is increasingly important for universities, colleges and training programs to develop the talent base and workforce who understand the technological, environmental and social co-dependencies needed for true innovation. Innovation that will help the U.S. reduce our impacts on the global climate, innovation that will reduce energy poverty in rural communities, and innovation that will allow us to sustainably explore and harness our ocean resources.

This workforce is required now. The students that graduate from programs and centers, like PMEC, are in increasing demand at private companies, national laboratories, and within the

broader academic community. We need to ensure that the financial support is available to ensure that PMEC and other similar centers can continue to provide this workforce – a very real concern that is frequently noted by our industrial and national laboratory partners. It is my sincere hope that the *Water Power Research and Development Act of 2019* will provide one of the fundamental building blocks to ensure we are able to create this next generation workforce.

In closing, I thank the Subcommittee for your efforts to consider the opportunities associated with the development of a thriving marine energy industry in the U.S. With the right support, the U.S. marine energy industry can capture a significant share of a massive emerging market, assist in our transition to carbon-free electricity generation, and develop the next generation of renewable energy leaders. I would be pleased to answer any questions about this testimony, the Pacific Marine Energy Center, or the marine energy industry writ large.

Sincerely,

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Dr. Robertson is the co-Director of the Pacific Marine Energy Center (PMEC) and an Associate Professor in Civil Engineering at Oregon State University. He has a Bachelor of Mechanical Engineering from the University of Victoria, and a PhD in Environmental Engineering from the University of Guelph. He has spent the better portion of the past 20 years actively involved within the North American marine energy market, energy systems and coastal engineering sectors. From helping design the hybrid renewable energy system for the Race Rocks, the first tidal energy turbine deployed in North America (2004), to his current role with PMEC, his involvement has included conducting fundamental research within universities, developing commercial products within industry, and helping government organizations develop implementation roadmaps for marine energy commercialization. His research and professional portfolio covers the full development cycle for marine energy systems with expertise that includes resource assessments, to technology development, to market opportunity evaluations. Dr. Robertson have worked with large multinational corporations, small technology developers, private NGO's, tribes, large electrical utilities, and international information technology companies to better understand their roles and opportunities in this emerging sector. Additionally, his research efforts also include long-term electricity system transition analyses. As North American electricity systems rapidly evolve, it is imperative that we understand the opportunities and challenges at the nexus of global economic growth, climate change, renewable technology development, policy ambitions, and human social structures.