

An unending supply of ocean energy. A unique intersection of powerful waves, wind and vast ocean. A field of emerging technological knowledge to harness this energy. A large, promising marketplace to supply that energy to the grid. Each is a key component in making Oregon a global leader in clean, sustainable ocean energy.

Energy – where it comes from, how we use it, how much we pay for it, and how we make the transition to an independent renewable energy future – will define us as Oregonians for generations to come.

In 2007, we passed energy legislation – including renewable electricity and renewable fuels standards – that will keep Oregon in the forefront of the fight against climate change, and move us toward a clean energy future. Under these standards, 25-percent of Oregon's electricity will come from renewable sources by 2025.

I am committed to continuing our aggressive investment in alternative and renewable fuels; energy conservation and efficiency; green technology and the jobs that are created from that technology; and policies that reduce our dependence on fossil fuels – and spur sustainable development.

The Oregon Wave Energy Trust is a public-private partnership funded by the Oregon Business Development Department through its Oregon Innovation Fund to help responsibly develop the wave energy industry in Oregon. It has made great strides in the past two years and has earned my continued support as a result. I am optimistic about the potential environmental and economic benefits for the State.

Theodore R. Kulongoski  
Governor of Oregon

Oregon Wave Energy Trust (OWET) is a nonprofit public-private partnership funded by the Oregon Innovation Council. Its mission is to support the responsible development of wave energy in Oregon. OWET emphasizes an inclusive, collaborative model to ensure that Oregon maintains its competitive advantage and maximizes the economic development potential of this emerging industry. Our work includes stakeholder outreach and education, policy development, environmental assessment, applied research and market development.





**The ocean is the largest, most concentrated supply of renewable energy on earth. It could provide ten percent of the world's energy.**



**Americans consume 25 percent of the world’s energy, even though the U.S. holds only 5 percent of the world’s population. At the same time, demand for energy around the world is growing and worldwide consumption of energy is expected to grow with it. In addition, conventional fossil resources (oil, coal and natural gas) that are finite in nature face supply constraints and volatile markets. While we search for new sources of energy, concerns about economics and climate change have become widespread. That has led to the search for new sources of renewable energy.**

**Ocean Wave energy is always available** Unlike other renewable power sources, ocean wave energy has the potential to be available all the time. There is even more energy available in the waves on the Oregon Coast in the winter, when the region uses the most energy.

**Ocean Wave energy is predictable** Wave patterns, height and strength can be accurately predicted days in advance.

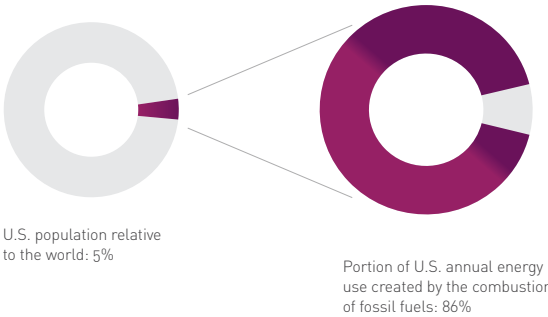
**Ocean Wave energy is reliable** In Oregon, wave energy will be generated close to where most of the power is consumed. This increases reliability of the transmission grid and reduces inefficiencies of transferring power from the eastern parts of the state. The entire Oregon Coast is connected to Bonneville Power Administration transmission lines, so the power can be easily moved to where it is needed.

**Ocean Wave energy reduces our reliance on fossil fuels** Adding wave energy into the resource mix will help the state reach greenhouse gas emission targets, including carbon reductions of 10 percent by 2020 and 75 percent by 2050.

**Ocean Wave energy is clean and renewable** The ocean is the largest, most concentrated supply of renewable energy on earth, and has the potential to provide 10 percent of the world’s energy. Wave energy is clean, predictable and renewable. It has no greenhouse gas emissions, produces no pollution and requires no major drilling or mining.

**OWET is working to diversify the energy mix** There is no single solution to the energy challenge. The best energy solution is one that encompasses many different kinds of energy generation. If one energy source is off-line, unavailable or experiencing price shocks, other sources can be stepped up to meet demand and maintain reliability and price stability.

**Measuring the impact on the ocean and the environment** Preserving ocean space and its natural environment is important to all people. The wave energy industry is working closely with existing user groups and community leaders to identify areas that offer the least impact to past, present and future ocean users. Robust environmental study and monitoring plans will be a critical part of all energy projects. Oregon Wave Energy Trust works with highly qualified researchers to determine the impacts, if any, on different fish species.



Wave energy is clean, predictable, renewable and, unlike other renewable resources, has the potential to be available 24/7. It has no greenhouse gas emissions, produces no pollution and requires no major drilling or mining. The Oregon Coastline is among the few places in the world that possess the four key elements necessary to tap into this clean, renewable and sustainable source of energy today: an abundance of energy generated by ocean waves border-to-border, internationally recognized experts leading the effort to develop the technologies to capture and convert wave power, the ability to supply that power to the grid, and sea ports ready to build, maintain and deploy wave energy conversion devices.

**OWET’s purpose is to reduce barriers to getting wave energy projects into the water, whether the projects are prototype deployments or commercial installations. OWET sponsored programs seek to support the responsible development of the wave energy industry. Because the industry is at an early stage in its development, there are still numerous technology design concepts being studied and tested. Oregon and OWET form a strong partnership in achieving economic benefits for the state.**

By the end of 2009, OWET had funded over 20 projects that have engaged stakeholders, independently answered important questions about the human, economic and environmental impacts of the wave energy industry in Oregon, offered shared expertise to map out and streamline the permitting process, driven demand, and brought regional utility partners to the table.

**Balancing the use of the ocean** OWET works with stakeholders, industry and local communities to explore the balance among existing ocean uses and wave energy projects and the industry.

**Regulation** OWET has commissioned the creation of information tools for developers and stakeholders navigating the wave energy regulatory environment, including the most relevant state and federal requirements, as well as having identified the lead and participating agencies for each authorization required.

**Environmental impact** OWET has sponsored environmental research projects to better understand the potential impacts of wave energy projects on the environment. The selection of these studies has been informed by the study plans generated by wave energy project development on the Central Oregon Coast.

**Applied research and development** OWET has initiated applied research projects that provide information and guidance for developers seeking to deploy –or prepare to deploy – prototype and commercial wave energy installations in Oregon.

**Partnering with OWET** To assist companies that are involved with lab and wave tank testing and computer modeling, Oregon boasts a strong university system, including the facilities at Oregon State University, like the Hinsdale Wave Tank and Wallace Energy Systems and Renewables Facility. OWET will continue to work with its partners and will sponsor initiatives that provide opportunities to advance wave energy. Where companies are deploying scaled prototypes, there is the Northwest National Marine Renewable Energy Center (NNMREC), the wave regime of the Oregon Coast and the state’s pool of highly capable metals manufacturers, fabricators, integrators and logisticians.

**Development in Oregon** Finally, for those companies ready to launch full scale commercial or pre-commercial projects, OWET programs have identified and resolved barriers and begun to answer key questions surrounding development. Development in Oregon can include a series of state and federal incentives (more info is listed on page 18), grid access to the Northwest’s utilities and a level of professional fluency in wave energy unrivalled in North America. OWET offers a foundation from which wave energy companies can look to Oregon as a place to do business, leading to increased investment, continued skills development and clean energy generation from a new renewable energy resource.

YEARLY AVERAGE WAVE ENERGY  
FLUX IN KW PER METER

Wave energy is created by large storms hundreds of kilometers offshore that generate and transmit huge amounts of energy. This energy travels great distances (via swells) and mixes with local influences (seas) to arrive on shore.

The World Energy Council has estimated that approximately 2 terawatts (2 million megawatts) – about double current world electricity production – could be produced from the oceans via wave power.



<http://www.geni.org/globalenergy/library/technical-articles/generation/tidal-wave-ocean-energy/energycentral.com/The-Potential-of-Ocean-Power/index.shtml>

Clearinghouse

Act as an information hub for industry, identifying and resolving barriers, and linking groups to provide a forum for wave energy stakeholders. Information garnered from OWET sponsored studies remains in the public domain.

Outreach between  
Coastal Communities and Public Agencies

Supports information and economic development opportunities of wave energy in Oregon. Partnered with OCZMA.

Conferences

OWET’s conferences aim to connect developers, industry specialists, researchers and policy-makers in order to spur conversation, disseminate knowledge and create dialogue.

Community Engagement and Outreach

Engages local communities in outreach information and activities. Partnered with Oregon State University Sea Grant.

Market development

Initiate and support market development activities for the wave energy industry.

Industry Matching Funds:  
Douglas County Project Development Grant

Matching grant provided for research projects for Douglas County’s FERC license application. Partnered with Douglas County, Oregon.

Industry Matching Funds: Reedsport /  
Winchester Bay Project Development Grant

Grant to implement specific research projects for OPT’s FERC license application.

Industry Matching Funds:  
Coos Bay Project Development Grant

Grant to implement specific research projects for OPT’s FERC license application.

Marine Energy Interest Working Group (MEIG)

Co-sponsord creation of, and participation in, forums to exchange information on marine-energy electric generation technologies, applications and market developments. Partnered with Electric Power Research Institute.

Coastal Infrastructure Inventory

Assessment of the needs of the wave energy industry and infrastructure in Oregon to support them. Partnered with Advanced Research.

Utility Market Initiative (UMI)

Creation of an effective strategy, including applicable tools, to help build a utility/wave energy industry relationship and guide the integration of wave energy projects in the electric utility system. Partnered with Pacific Energy Ventures.

Applied research and development

Initiate applied research projects that answer questions surrounding development.

Advanced Anchoring and Mooring Study

Established an industry knowledge base for existing anchoring and mooring techniques and recommendations for future analysis. Partnered with Sound and Sea Technologies.

Acoustic Characterization Study

Cash match to support NNMREC’s test berth development through an Acoustic Characterization study. Partnered with NNMREC.

Electromagnetic Measurement Methods

Determination of methods, protocols and measurements for acquiring reliable and affordable Electromagnetic Field (EMF) measurements for wave project sites. Partnered with SAIC.

Sediment Transport Baseline Observations and  
Modeling for the Reedsport Wave Energy Site

Assess the potential effects of wave energy devices on sediment transport and on the morphology of beaches. Partnered with OSU and DOGAMI.

Assessment of Underwater Noise  
Generated by Wave Energy Devices

Document a methodology for measuring the existing environmental conditions for comparison to the noise spectra generated by wave energy devices. Partnered with JASCO Applied Sciences.

Environmental research

Initiate environmental research projects to answer questions key to wave energy development.

Dungeness Crab and Fish Baseline Study

Established consistent baseline data for sub-adult and adult Dungeness crab in and around potential project sites. Partnered with HT Harvey and Associates.

Marine Mammal Study

Phase 1 survey of migratory routes and potential locational effects of wave energy development on gray whale migration. Partnered with Oregon State University (OSU).

Cumulative Effects Framework

Quantitative means for assessing the environmental and socio-economic impacts of multiple wave energy projects. Partnered with Aquatera and Parametrix.

Baseline Seabird Assessment

Implemented a seabird count and species distribution survey in the Coos Bay region. Partnered with National Oceanic and Atmospheric Administration (NOAA).

Ecological Effects Scientific Workshop

Scientific workshop to determine the state of knowledge on the potential effects of wave energy technology on the ecological and physical components of coastal ecosystems. Partnered with National Oceanic and Atmospheric Administration (NOAA), Oregon Department of Land Conservation and Development (ODLCD), and Oregon State University (OSU).

Bird Baseline Study  
Bird Radar Study

Establish consistent baseline bird data in and around potential project sites utilizing bird radar. Partnered with Geo-Marine Inc.

Policy and regulation

Support policy and regulatory framework development to advance the wave energy industry.

Human Dimensions of Wave Energy

Multidisciplinary research program to understand how economic cost and benefits are interdependent and linked to values, perceptions, policies and decisions. Partnered with OSU.

Economic Impact Analysis of Wave Energy

Estimated potential net economic impacts of wave energy industry development in Oregon. Partnered with ECONorthwest.

Wave Energy Regulatory  
Analysis and Recommendations

Established guidelines that address stakeholders’ needs and interests while providing a clear, coordinated roadmap for wave energy development. Partnered with Pacific Energy Ventures.

Fishing Industry Mapping

Developed comprehensive spatial representation of commercial and recreational fishing use patterns. Partnered with ODLCD, OCZMA and Ecotrust.

International Standards Development  
for Marine Renewable Energy

Assist in the development of marine energy industry standards, provide consistency and predictability to their development, and increase US industry’s collaboration and representation in the development process. Partnered with SAIC.



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Kevin Banister

**Private industry match program** OWET provided a pool of matching funds to proponents developing grid-connected wave energy projects that have reached a substantive stage of development. In addition to site specific work, some of the studies and tasks funded through the program are informed by project agreements and the study plans that they generate. The information that is developed from OWET matching funds enters the public domain and has the potential to be useful to other developers as they develop projects.

**Sediment transport analysis** The wave energy industry needs to understand the near shore environment and to establish a consistent, appropriate methodology for pre and post deployment analysis. This study framework evaluated the effects of wave energy conversion devices on wave attenuation and sediment transport. The project established a pre-deployment profile and methodology for identifying the potential effects. Information gathered from this project provides the basis for future commercial projects and is applicable to proposed projects along the Oregon Coast.

**Cumulative effects** OWET commissioned the creation of an analytical framework for evaluating the cumulative effects of wave energy projects that resource managers, other decision makers, the public and the wave energy industry can use to evaluate possible cumulative environmental and socio-economic effects of wave energy within Oregon’s Territorial Sea. The development of this framework provides strategic tools for the community for project development that achieves the lowest possible impacts and highest stakeholder acceptance.

**Regulatory roadmap** OWET commissioned the creation of an information tool for developers and stakeholders navigating the wave energy regulatory environment. The report identifies the most relevant state and regulatory requirements, explains the authorization process, and identifies the lead and participating agencies for each authorization. The document is organized into sections that provide a roadmap for the regulatory process.

**Coastal infrastructure** As the industry begins to transition from small to large-scale R&D into the project development phase, the underlying infrastructure required to support this transition needed to be examined. Assessment of the state’s infrastructure begins with a review of the basic sectors (manufacturing, transportation, O&M), where capabilities and resources are present. Detailed interviews were conducted with the key providers such as port directors, local governments, and manufacturers. Future plans are included as best-to-worse case scenarios for each region.

**Anchoring & mooring** The installation and operation of wave energy conversion devices in project sites present new opportunities and challenges for the emerging industry. OWET commissioned a report that provides a comprehensive guide to anchoring and mooring concepts that are applicable to each unique set of conditions and device characteristics. It also identified the iterative design process needed to arrive at an optimum design for the system, as well as identifying gaps for each anchor and mooring type deemed to have serious potential for wave energy installations.

**Whale migration study** Some wave power projects will be anchored to the sea floor via a series of cables and anchors. How whales will interact with these devices is largely unknown. During the early Winter and late Spring, more than 20,000 grey whales migrate between Baja California in Mexico and the Bering Sea. Their migration path ranges between 100 yards and five miles offshore. This study is the first phase of a project plan that will more precisely determine their migratory paths along the Oregon Coast.

**Fishing mapping** The goal of the fishing industry mapping project is to compile a comprehensive map of the commercial and recreational fishing use patterns of the Oregon Coast. Elements of this report will be incorporated into future amendments of the Oregon Territorial Sea Plan and will assist in the development of accurate maps of local fishing grounds and their economic importance to the fleets. This will be of incredible value to the development community as it illustrates ‘no conflict’ zones.

**Community engagement and outreach** An important element of OWET’s mission to help the wave energy industry develop responsibly in Oregon is to involve the communities that have the potential to be most affected. Assuring that they are informed and able to contribute to the dialogue is fundamental to responsible development. OWET engagement and outreach funding has assisted with the formation of fishing groups and enabled dialogue with public entities along the Oregon coast.

**Utility market initiative (UMI)** OWET seeks to build and establish understanding between the Northwest’s electric utilities and the wave energy development community. The UMI project has generated reports that describe the regional energy picture and the region’s approach to long-term resource planning and acquisition—with the purpose of defining how wave energy fits with the existing and future resource portfolio. Conversely, the program assists the utilities to learn about technologies, the process for moving from pilot to commercial scale, and best-practices for developing new projects.

The Northwest National Marine Renewable Energy Center is one of only two US Department of Energy-sponsored marine renewable energy centers.

The mission of NNMREC is to facilitate commercialization of marine energy technology, inform regulatory and policy decisions, and close key gaps in scientific understanding. Oregon State University, with assistance from OWET, was awarded \$6.25 million by the US Department of Energy to develop NNMREC and establish a test-berth facility. OSU will deploy various devices near Newport, Oregon to study new technologies and evaluate their effect on the environment.

**NNMREC activities are structured to close key gaps in understanding, inform regulatory and policy decisions, and facilitate wave energy conversion (WEC) device commercialization. NNMREC evaluates the potential ecosystem and human dimensions impacts. It focuses on the compatibility of marine energy technologies with ocean and coastal environments and coastal users. NNMREC serves as an integrated, standardized test center for U.S. and international developers of wave and tidal energy.**

**About NNMREC** In the fall of 2008, the US Department of Energy established the Northwest National Marine Renewable Energy Center (NNMREC), directed by OSU mechanical engineering professor Bob Paasch, as a collaborative effort between OSU, University of Washington, and the National Renewable Energy Lab. NNMREC includes researchers from the colleges of Engineering, Oceanic and Atmospheric Sciences, along with Oregon Sea Grant, the Cooperative Institute for Marine Resources Studies, the Marine Mammal Institute, and the Hatfield Marine Science Center. Primary NNMREC activities include: development of test center facilities for US and international wave developers, evaluation of potential environmental and ecosystem impacts of marine energy technologies, effective deployment of wave and tidal energy technologies, increased reliability and survivability of marine energy systems, and dissemination of marine energy information.

**Methods and impacts** NNMREC efforts will include the development of “mobile” test berths for full-scale wave device testing. Testing and evaluation will identify best practices for maintenance and quality control of wave energy systems and will refine wave energy power measurements.

**Instrumentation packages** NNMREC efforts also focus on the development of a “mobile” instrumentation package for tidal device and environmental monitoring. The package will leverage the expertise of industry partners to address the needs of all stakeholders in a cost-effective manner.

**Environmental and ecosystem impacts** Research will be conducted using numerical models of devices operating in coastal and estuarine environments, validated by observational data from pilot testing. The focus will be on the effects of large-scale deployment of wave energy technologies upon the surrounding environment and ecosystem. Results will be shared with local, state, and federal agencies to inform policy decisions, and presented to the general public through educational workshops.

**Wave energy forecasting** Utilizing detailed numerical models calibrated against observational data from pilot tests, studies will be conducted on individual wave energy-related devices. As the research progresses, the scale will include an array of devices for investigation of both near- and far-field dynamics.

**Forecasting wave energy** Through research and continued studies, wave energy forecasting will be improved for offshore locations and extended to the near shore environment where wave energy devices will be deployed.

**Long-term materials** NNMREC will continue efforts to study and improve long-term reliability and survivability of corrosion and bio-fouling resistant materials, including new structural composites.



WORLD PRIMARY ENERGY CONSUMPTION (10<sup>15</sup> BTU)



WORLD POPULATION DENSITY PERSONS / SQ KM



<http://upload.wikimedia.org/wikipedia/commons/7/7d/Energy-consumption-World2.png>

[http://www.catsg.org/cheetah/07\\_map-centre/7\\_1\\_entire-range/thematic-maps/global\\_population\\_density.jpg](http://www.catsg.org/cheetah/07_map-centre/7_1_entire-range/thematic-maps/global_population_density.jpg)

**The energy potential of the world's oceans is astounding, enough to light up the world. The ocean supports 71 percent of the Earth's surface and contains 97 percent of the planet's water. The ocean supports the life of nearly 50 percent of all species on earth.**





**Join us in our effort to establish Oregon as the leading wave energy generator in the US. OWET works continuously with stakeholders to balance the uses of the ocean and to examine the impact on all who are affected. This is an inclusive process. OWET brings Oregon’s diverse oceanic communities and industries together to responsibly develop the wave energy industry – from ocean wave energy companies, to fishing and environmental groups, local, state and federal agencies, elected officials, and other community representatives.**

Oregon’s Renewable Portfolio Standard requires utilities to provide an increasing percentage of energy from renewable resources, a definition that includes ocean-derived energy. By 2025, 25 % of the load of the state’s larger utilities must be served from renewable resources. The following grants, loans and tax credits provide financial assistance and incentives to invest in new, renewable energy sources:

**Business Energy Tax credits** The business energy tax credit (BETC) funds research development and demonstration, renewable energy project development and renewable energy facilities construction. Credits range from 35% to 50% of eligible costs depending on the project type.

**Small Energy Loan Program** Certain wave energy projects may qualify for the state’s Small Energy Loan Program. Depending on the project, low-interest loans may be offered that range from \$20K-20M. Terms of the loan are from five to 20 years.

**Federal Government Programs** In addition to Oregon based incentive programs, the government has begun to promote renewable energy. Funding for ocean energy related programs at the US Department of Energy has increased significantly in recent years. Additionally, wave energy development companies can access Small Business Innovative Research (SBIR) grants, loan guarantees for renewable energy projects, and other evolving opportunities.

**Investments** In 2008, industry partners in Oregon secured approximately 25% of the competitively solicited federal ocean energy budget. OregonInc’s initial \$4.2 million investment in OWET has already attracted an additional \$10 million of investment to the State, resulting in over a 200% return on investment.

In the coming biennium, OWET will continue programmatic efforts in policy, market development, and outreach, with work in each that will emphasize long term job creation through the development of the wave energy industry. To further leverage state and federal investments in NNMREC, OWET will prioritize matching contributions for technology development in coordination with NNMREC. OWET’s multi-focused approach enables the state to take economic advantage of this evolving and promising industry – from start-up technologies developing intellectual property to commercial project development in the state.

Our work will not be easy. We are essentially transforming decades-old land and ocean use policies to adapt to new markets and technologies. There are many moving parts, sometimes opposing interests, and antiquated rules of engagement. OWET is here to streamline the regulatory process and be a catalyst for efficiency and the responsible development of wave energy.

**Join us.**

**Why support Oregon Wave Energy Trust?**

Oregon Wave Energy Trust (OWET) works closely with stakeholders: fishing and environmental groups, coastal communities and industry, government agencies and other partners in responsibly developing this new industry while establishing Oregon as the North American leader in wave energy. The work that we do is the real benefit we offer our members.

Additional benefits of becoming a member include: a listing on our website for 12 months, subscription to periodic e-news, breaking news alerts and discounts for OWET events.

There are many different ways to get involved. Please contact us by e-mail to discuss opportunities and benefits: [info@oregonwave.org](mailto:info@oregonwave.org)

OWET is a 501(c)(6) organization. Memberships are deductible pursuant to IRS guidelines.



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