OCEAN SPACE, OCEAN PLACE

The Human Dimensions of Wave Energy in Oregon

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ABSTRACT. The Pacific Ocean is becoming valuable real estate. Fights over this space resemble those of the gold rush. Decision makers require data to integrate new uses (wave energy) with existing uses (commercial/recreational). It is vital to have the best data available and implement the best management practices concerning the environmental dimension. Yet, permitting processes rarely fail on technical or natural science grounds; rather, they fail because of lack of attention to the human dimension. Legislators and resource managers need to understand socioeconomic and sociopolitical perceptions. This knowledge is crucial for allowing citizens to determine their interests and civic opportunities. An informed and engaged public is essential to progress on environmental protection and sustainable development. It is important to assess the scope and depth of policy-relevant knowledge among stakeholders and the public, to learn where they acquire their information, and to flesh out the link between policy-relevant knowledge and understanding/acceptance of wave energy generation. By specifying the connection between knowledge holding and support for wave energy, purposeful public education and information dissemination efforts could be targeted effectively, and policy processes could be designed to maximize policy input and meet citizen and community concerns. This research program looked at wave energy in terms of political/regulatory processes and environmental, social, and economic sustainability and acceptability.

INTRODUCTION

The Beginning of the End

The Pacific Ocean—once viewed as vast and open—is no longer the frontier. Rather, in many ways, it has become valuable "real estate." Fights over the space resemble those of land-grant claims and the gold rush. Claims are being staked, bets are being made, and the risks seem high.

Oregon's nearshore ecosystem underpins its commercial fisheries and recreational use. According to a 2006 report issued by the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS), commercial landings in Oregon were valued at over $1.7 billion (NOAA, 2006). According to the Oregon Department of Fish and Wildlife (ODFW), fisheries for Oregon Dungeness crab, pink shrimp, and sablefish comprised the three most valued landings in 2008 (ODFW, 2008). Recreational fisheries are more difficult to value because landings are not sold on the wholesale market; however, the 2006 NMFS report indicates that this sector provided more than $250 million to Oregon's economy as a result of drawing in charter-boat customers, who then support lodges, restaurants, bait shops, and other local businesses (NOAA, 2006). Similarly, nonextractive recreational users, including surfers, sea kayakers, scuba divers, and general beach visitors, are active along Oregon's coast. There is little information available, but a recent study estimated active surfers spend more than 70 days a year in Oregon's surf (Stone et al., 2008).

Technology development and research investigating and supporting the development of ocean-based renewable energy had been going on for several years, but by 2004 interest exploded. Technical assessments were indicating that Oregon was well suited for the technology because of its abundant wave resource and supporting coastal infrastructure to transmit the electricity to coastal populations. Developers were eyeing Oregon as a "sweet spot" to test and launch their technologies. First, there were two preliminary permits, then five, then seven. Terms like "the gold rush" were being used to describe the situation.

A Renewable Portfolio Standard (RPS) is a regulation that requires the increased production of energy from renewable energy sources, such as wind, solar, biomass, and geothermal. Over the last two decades, many states have adopted such standards to address concerns about energy independence and greenhouse gases, and to capitalize on opportunities to grow their economies (Huang et al., 2007). In 2006, the Oregon governor proposed an RPS for Oregon that called for 25% of the state's electricity to be generated from renewable sources by 2025 (Kulongoski, 2006). In 2007, Oregon's legislature passed Senate Bill 838, which codified the governor's target, as well as additional bills that provided for a variety of renewable incentives and efficiency improvements, including funding for research and development and tax credits for renewable technology firms and homeowners who installed energy-efficient appliances (ODOE, 2007).

The wave energy industry benefited from this policy in particular, with over $4 million to fund the Oregon Wave Energy Trust (OWET) for the purpose of promoting the technology's development off Oregon's Coast. OWET's efforts to facilitate wave energy development include identifying ecological and economic research needs, addressing the complex state and federal regulatory framework, and developing outreach strategies to work with communities affected by these developments.

Yet, as recently as 2007, policymakers continued to struggle to keep up in many ways. Who is responsible for planning and regulating this new use of the ocean: the Federal Energy Regulatory Commission (FERC), Minerals Management Service (MMS), or local or state governments? What should the processes be for permitting and what are all of the correct steps that should be followed?

Wave energy technology, at this point, has yet to be commercially proven. While the intended purpose of ocean wave energy is to yield a carbon-free, renewable supply of electricity both locally and regionally, the potential environmental and social impacts of wave energy remain largely unverified. The many unanswered environmental questions led to a 2007 workshop on "Ecological Effects of Wave Energy Development" at the Hatfield Marine Science Center in Newport (proceedings available at http://hmsc.oregonstate.edu/waveenergy). This workshop was a one and one-half day meeting with a goal of (1) developing an initial assessment of the potential impacting agents and ecological effects of wave energy development in the coastal ocean, and (2) developing a general framework that could be used to apply to specific wave energy projects. The workshop shared current understanding and initiated a broad discussion of the potential ecological effects of ocean energy. It did not attempt to discuss and vet policy issues pertaining to wave plants; rather, it focused on building capacity to more adequately address the potential ecosystem impacts of wave energy development in the Pacific Northwest.

Equally important yet left unaddressed were a series of human dimension issues and questions. Proponents of wave energy hope to offset dependence on conventional energy sources while

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harnessing local renewable energy to claim regional and global leadership in wave energy development and green-collar job creation. It is argued that both coastal and noncoastal communities would share in the benefits of electricity consumption derived from wave energy. However, potential impacts of development projects of this nature can be perceived as either benefits or risks (Thomas, 1981; Lee, 1987). How is wave energy generation off the Oregon coast being perceived in general? Who are the stakeholders and how are they engaged? Is this activity further defining differences in rural and urban perceptions of the coast and the direction of its economic and social development? Cumulatively, how does the human dimension of the wave energy equation impact public perceptions, public policy, and the successful adoption of wave energy technology along Oregon's coast?

In 2007, OWET put out a request for proposals to begin to discover answers to many of the environmental and human dimension questions. A multidisciplinary group of social scientists from Oregon State University (OSU)—Flaxen Conway (Sociology), Michael Harte (Marine Resource Management), Brent Steel (Public Policy), and Bryan Tilt (Anthropology)—responded to this call. Success in finding funding from OWET and other sources allowed them to work together and create a new research program at OSU. The Human Dimension of Wave Energy (HDWE) research program was to provide a cadre of social scientists—professors and graduate students—the opportunity to study this transition to a new use of the ocean space and place.

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Why Invest in Human Dimension Research?

This new, proposed use of the ocean space and place is multidimensional and complex. Just as single research project cannot address all of the environmental issues, a single research project cannot address all of the human-dimension issues.

The emerging wave energy industry has the opportunity to develop in a sustainable and socially responsible manner. "Sustainable" development can be defined as development that satisfies the needs of the present generation without endangering future generations' capacity to satisfy their needs (United Nations, 1987). Energy is one of the most complex concerns in the dialogue of sustainability for two reasons. First, energy availability and access are closely related to economic and social freedoms. Energy, an essential good in constrained supply, could severely limit the public and private aspirations of individuals and nations (Simon, 2007). Second, many serious environmental problems are caused by the use of energy (carbon dioxide generated by the combustion of fossil energy contributes to climate change). These two reasons make the impact of energy on sustainability complicated.

What about "socially responsible"? Delli Carpini and Keeter (1996) noted over a decade ago that public knowledge "is essential if citizens are to discern their *real interests* and take effective advantage of the civic opportunities afforded them" (emphasis added). Daigle (2003) argues in favor of the need for greater public involvement in coastal policy issues, stating that "the only hope for further progress on environmental protection and sustainable development lies with a public that is not only informed but also engaged."

What role does proximity play? The perspectives of those living and working in closest proximity to development sites are critical to the people charged with developing the technology, the regulatory framework, and the economic distribution regimes that govern these sites (Bennett, 1986).

Therefore, we believed it important to

(1) assess the scope and depth of policy-relevant knowledge among stakeholders and the public, (2) learn where people acquire their information about wave energy, and (3) flesh out the link between policy-relevant knowledge and understanding and acceptance (or rejection) of wave energy generation. By more clearly understanding the connection between knowledge holding and support for (or against) wave energy, purposeful public education and information dissemination efforts could be designed and targeted more effectively. In addition, policy processes could be designed to maximize policy input and meet citizen and community concerns. In short, HDWE was designed to discover and document baseline information—about the best available socioeconomic/sociopolitical information and best management practices—that could be used to inform people, businesses, and policymakers and their decisions regarding wave energy planning, permitting, and implementation.

METHODOLOGY

In the fall of 2007, six graduate students—five master's candidates (Holly Campbell, John Stevenson, Zack Covell, Daniel Hunter, and Yao Yin) and one PhD candidate (Maria Stefanovich)—were enrolled in classes, ready for research projects, and, most importantly, interested in this topic. Existing agreements and small grants here and there, along with funding from OWET and Oregon Sea Grant, resulted in a modest, leveraged budget to support this effort.

HDWE investigated the human dimension complex through six related but independent research projects in four thematic areas.

Thematic Area 1. The Socioeconomic and Sociopolitical Influences on Wave Energy Permitting and Planning

This thematic area had two research projects associated with it. The first (Stefanovich) project comprised mail surveys sent in fall 2008 to a random sample of 1,600 households statewide (56% response rate) to determine the level, depth, and connection between people's knowledge, values, and opinions and their actions/resources in support of or opposition to wave energy (regionally, nationally, and internationally). The second (Stevenson) project focused on the role of government, citizens, and science in the implementation of energy policies. Fourteen key informant interviews and a mail survey (n = 352; 50% response rate) were conducted in fall 2008/winter 2009, working with federal, state, and local governments; technical experts (scientists/engineers); the energy industry (e.g., developers, fabricators, labor unions); electric utilities; commercial and recreational fishers; recreational users (surfers/kayakers); conservationists; and media. This project studied the roles played by government representatives, community leaders, and technical experts; who controls critical resources; and the strategies and venues used to achieve their objectives. This thematic area provided information about the best management practices for identifying and addressing social and political acceptance or resistance regionally and nationally within the United States as well as internationally.

Thematic Area 2. A Comparison of Wave Energy Generation to Other Forms of Electricity Generation

This project (Yin) involved reviewing and synthesizing the existing literature and secondary data comparing the sustainability and acceptability of wave energy and eight other electricity-generating energy sources in Oregon (liquefied natural gas, oil, nuclear, hydro, wind, biomass, solar, and geothermal). The project was centered on three widely accepted dimensions of sustainability—economic, ecological, and social—with political institutions shaping the "overall" aspect of energy sustainability. It developed three sets of indicators to characterize or operationalize sustainability and generated sustainability matrices to summarize what had been documented to date. This comparison provided useful information to determine the best ways to avoid or overcome risks and barriers.

Thematic Area 3. Ocean Zoning in Oregon and Around the World: An Assessment of Best Legal and Regulatory Practices for Permitting and Managing Wave Energy in Oregon

This project (Campbell) called for looking beyond existing ocean energy laws and regulations to seek approaches from other ocean resource laws and regulations applicable to ocean energy development in Oregon; it examined international, regional, and national examples related to other uses of the coastal ocean. Although details are constantly changing, this work provided a snapshot of the best management practices within the US and internationally for permit streamlining and expedited rollout of emerging energy technologies.

Thematic Area 4. A Snapshot of Perceptions of, and Effects on, Communities of Place and Communities of Interest

There were two projects associated with this area. One (Covell) was based on 15 key informant interviews and a mail survey done in spring 2009 (n = 289; 36.2% response rate) to investigate communities of interest (organized interest groups) in five categories: energy industry (developers and utilities); workforce (unions, workers, management); environmental/conservation; commercial fishing; and recreational users. This project yielded data regarding how informed and involved these groups are. The other project (Hunter) was based on interviews conducted from July to November 2008 in three coastal communities of place (47 coastal Oregonians participated—17 from Tillamook County, 18 from Lincoln, and 12 from Douglas) in order to investigate whether, and how wave energy affects them economically and socially, or could affect them in the future. This work provided information useful in promoting the wave energy industry and ensuring responsible wave energy development.

RESULTS AND LESSONS LEARNED

Governance

Results from the research projects reflected much that could be learned about governance. Greater capital flow—provided by the private sector *and* by government—was indicated to be the stimulus that could best aid deployment of wave energy technology. Government could create energy policies that (1) help to develop emerging and improved technologies; (2) underwrite the cost of introducing technologies into the market, improving technical performance, and encouraging development of an industry; and (3) provide a competitive market framework, and internalize externalities in terms of energy security, environmental protection, and economic efficiency.

Sound planning was seen as critical. Yet, plans and maps produced should be used for purposes beyond energy siting. Money and time spent on planning and mapping ahead of the introduction of new uses could save a lot of dollars over the long term. Public and private investments should advance the greater body of wave energy science, and environmental and human dimension data should remain public and accessible.

The greatest area of agreement among those who participated in the research program was that testing wave energy projects is essential. Many stakeholders felt that demonstration projects (on-ocean testing) would provide an opportunity to obtain scientific information helpful in the creation of policies and planning. There were similar findings in a report on sustainable energy for Ireland (AEA, 2006), which suggests that sufficient demonstration of multiple full-scale prototypes in a pre-commercial farm for years, not months, would provide data that could directly improve design and function, enhance investor confidence, and lead to a better understanding of environmental impacts.

The most significant areas of division and conflict that arose from our studies were related to two areas: (1) inflexibility on wave energy project location, and (2) attempts to secure permits for commercial-scale wave parks before developing a demonstration project. Decision makers should emphasize testing wave energy through cooperative processes that include stakeholders in decisions about project location and environmental monitoring protocols, and they should take advantage of state and local governments' central roles among stakeholder groups. State government may offer bridges among the federal government, conservation groups, and electric utilities, while local government may offer the same for fishing groups.

Public Perception

Results from this research program yielded much about public perceptions regarding energy and wave energy. Overall, energy knowledge is quite good in Oregon; only 9% did not give any correct answers to questions testing energy knowledge.

Generally, Oregonians exhibited positive attitudes toward wave energy development (52%). Yet, many (35% statewide) did not have enough information to form an opinion. There were regional differences in attitude toward, and level of familiarity with, wave energy development. Coastal residents held more defined and intense opinions—59% had a positive attitude—and they had more information on which to form opinions than Oregonians living in the rest of the state.

Respondents who had positive attitudes toward wave energy development were predominantly male, educated (finished some college or had a university diploma), lived in the Willamette Valley or on the Coast, and were over 56 years of age. They were employed and had medium to high income.

They held postmaterialist or mixed values, conservative policy preferences, and anthropocentric orientation toward the environment.

People who were "very familiar" with wave energy technology frequently got information about Oregon's energy situation and policy from universities, the Oregon Department of Energy, utilities, local leaders, and the Internet.

Stakeholders: Communities of Interest and of Place

Results from this research program yielded much about those who felt they had a stake in this ocean space, ocean place. Looking first at communities of interest, we found that each category of interest group appeared to be at a different stage of understanding and action when it comes to wave energy. Their primary sources of information were the energy industry, utilities, and technical experts (scientists, engineers). Yet, when asked to comment as to their "most-trusted" or "least-trusted" information sources, there were some sources trusted by some respondents but not by others. Overall, respondents indicated that their most trusted sources were technical experts and government. However, when asked about their least-trusted sources of information, results indicated the energy industry, technical experts, and the media; there was less agreement across groups, and the fact that technical experts are on both lists suggests many are still trying to figure out where to get trustworthy information.

We also learned about the connections within and between communities of interest. We found that there are both "ally" networks and "opponent" networks. Ally networks existed within government, between conservation and technical experts, and between local government and ocean users. Opponent networks existed between commercial and recreational fishing and the energy industry, technical experts, and federal and state governments as well.

Looking at communities of place, two perceptions crossed all study locations. The first was an expressed concern for the "well-being" of the communities, a concept that has been the subject of many studies. Much of the research on well-being has focused on objective measures such as economic indexes and household income, or subjective measures such as personal feelings and perceptions. Well-being has often gained audience from political spheres seeking direction in setting forth matters of public policy.

Testing of wave energy projects was the second area of agreement. Most believed that demonstration projects would provide an opportunity to gain the needed scientific information upon which to form more fully developed policy positions. Many articulated that decision makers should avoid predetermined project locations and should not authorize commercial-scale permits prior to developing demonstration projects.

Perceptions regarding wave energy could not be accurately predicted based on demographic group or county. Support for wave energy technology did not necessarily reflect an understanding of technological specificities. Rather, it reflected the particular social construction of wave energy as a source of (1) green renewable energy and job creation *or* (2) hazardous marine debris and job loss. Interview data from three coastal Oregon counties demonstrated conflicting assessments of the requirements and feasibility of the technology, the degree to which it could influence marine ecological dynamics, and the socio-economic value of historic and competing ocean uses. These assessments led residents to frame issues regarding wave energy development as either *opportunities for* or *threats to* one or more economic, political, or social dimensions of community well-being (Gramling and Freudenburg, 1992). These frames served as the basis for key decisions regarding both the role of government and preferred sources of funding for developing wave energy.

> "RESEARCH AND EXPERIENCE SHOW THAT PERMITTING PROCESSES RARELY FAIL ON TECHNICAL OR SCIENCE GROUNDS, BUT RATHER FOR LACK OF ATTENTION TO THE HUMAN DIMENSION."

Perhaps the best example of this, and a foundational block of community well-being, was the most commonly cited positive impact of wave energy development—the prospective employment opportunities it could offer residents of coastal communities. Given the chance to develop a promising new industry, many on the coast expressed willingness to promote wave energy as a source of job creation (skilled jobs in close proximity to project sites along the coast). An implicit assumption by those who argued that wave energy would create jobs was that the most likely candidates for these jobs are precisely the ones that will need them the most: fishers. This potential new wave energy industry also inspired some to envision growth in regional technical training programs as well.

Some saw wave energy as "the next big thing" for many workers and a way forward to economic growth on the coast. Others argued that jobs created by wave energy development would far from offset those lost as a result of it.

Therefore, when looking at economic aspects of community well-being, wave energy was characterized by a great deal of speculation and disagreement among residents of coastal communities. When wave energy was perceived as a source of job creation, it represented an opportunity for long-term economic sustainability. But when perceived as leading to short-term job loss, especially in the fishing industry, it was cast as a significant threat to community well-being.

Until communities experience the full spectrum of wave energy development on the ground, it remains to be seen how community well-being will actually be affected. Attitudes tended toward the extreme. Misconceptions were fueled by mutual distrust, and sources of valid information were limited to those with whom people felt most affiliated. Perceptions of potential threats and opportunities were likely shaped as much by residents' imaginations as by carefully examined empirical evidence.

Wave energy proponents could mitigate attitudinal extremism by focusing outreach efforts on local newspapers and the Internet. This focus could help dispel unrealistic expectations of potential benefits and exaggerated predictions of negative impacts with greater efficiency than periodic large public gatherings.

Wave energy proponents and policymakers often view public meetings as important ways to maintain a high profile within an affected community and to receive unfiltered feedback from concerned citizens. This sentiment was validated by respondents to our research who reported that few coastal residents actually used public meetings for gaining new information and learning about wave energy. Instead, to extend information and to build knowledge, third-party publications and relatively objective content could provide empirical evidence in support of continued wave energy research efforts. In addition, it would be important to reconfigure existing Web sites in order to cater to concerned community members, while still providing policymakers and industry agents separate content access points.

Wave energy proponents could gain community support for wave energy development by building partnerships with coastal community groups and having them cooperate in the research process. By allowing community members to participate, policymakers and wave energy supporters could provide a means for concerned citizens to help establish a relevant body of knowledge with high levels of community validity.

Sustainability and Acceptability

Oregon has been considered an ideal location with tremendous opportunity for wave energy development because of its abundant ocean resource and large transmission capacity (Oregon.Gov, 2008). However, sustainability and acceptability of wave energy in Oregon are different from opportunity.

Four comparison matrices were created to contrast all energy sources examined: an environmental sustainability matrix, an economic sustainability matrix, and a social sustainability matrix. Numbers were then assigned (one to nine) to all the electricity-generating energies, with "1" being least sustainable and "9" most sustainable. Scores that each type of energy received from three dimensions were then added and ranked in order of overall energy sustainability (Table 1).

However, a few caveats need to be shared. First of all, every area or location has its own environmental, economic, and social characteristics and an individualized political agenda (i.e., what is sustainable for Columbia River Gorge could be different from what is sustainable for Coos Bay). Finding a one-size-fits-all ranking is not likely. Second, there are many wave energy development unknowns, and more research is needed to determine how sustainable wave energy could be versus other sources. Despite this limitation, these preliminary results still provide a snapshot for comparing sustainability. Lastly, an energy acceptability matrix was created (Table 2) to show the environmental, economic, and social challenges and opportunities that might arise in developing each type of energy in Oregon.

Table 1. Overall Energy Sustainability Score

Energy Type	Environmental Score	Economic Score	Social Score	Overall Sustainability Score
Geothermal Power	8	7	8	23
Solar Power	9	1	9	19
Hydropower	5	6	6	17
Wind Power	7	3	5	15
Wave Energy	6	2	7	15
Liquid Natural Gas	3	9	2	14
Petroleum	2	8	3	13
Biomass Power	4	4	4	12
Nuclear Power	1	5	1	7

Table 2. Energy Acceptability Matrix

Geothermal Power	Geothermal power, in general, has been considered a promising energy source for Oregon, but acceptability still depends on how the development would be managed locally.
Solar Power	Oregon's solar-resource abundance and several hundred existing solar systems would be the basis for future development.
Hydropower	Growing need for surface water supply, aging infrastructures, and public's knowledge determines the acceptability of hydro in Oregon.
Wind Power	Transmission capacity between eastern and western Oregon and the cost of a small wind farm affect the acceptability of wind energy.
Wave Energy	Oregon has tremendous ocean resources and large transmission capacity to develop wave energy. Environmentally, we need more research locally to inform decision making. Economically, more incentives might need to be created. Socially, the public's knowledge of wave energy needs to be advanced.
Liquid Natural Gas	Environmentally, liquid natural gas is likely to receive opposition. Economically, it is not as feasible as regular natural gas from the Rocky Mountains. Socially, Oregonians are concerned about its environmental impacts.
Biomass Power	Biomass can enhance economy, although environmental pros and cons will need to be considered. Social acceptance is not certain.
Petroleum	Oregon does not have internal crude oil resources; all is imported and no refineries are available. No incentives targeting petroleum are found at the state level. Oregonians perceive petroleum as an aging, "dirty" industry with questionable long-term prospects.
Nuclear Power	Not acceptable in Oregon; voters approved an initiative limiting the licensing of new nuclear power plants in November 1980.

CONCLUSIONS

Research and experience show that permitting processes rarely fail on technical or science grounds, but rather for lack of attention to the human dimension. The emerging wave energy industry has the opportunity to develop in a socially responsible manner. But what does "develop in a socially responsible manner" mean? What steps must be taken to assure socially responsible development? Who needs to be involved? In other words, why engage with community? How should the energy industry (device and facility developers, utilities, technology manufacturers), policy and rule implementers (local, state, and federal-level decision makers), technical experts, and educators engage with stakeholders and the public in communities of place and interest?

In many ways, the results of the HDWE research program validate some of the core principles of community engagement. Decision makers should be encouraged to design and build strategies and engagement programs that assemble the three Cs: Connections (within and between people), Communication (direct and indirect), and Change (support smooth transitions through aiding adaptation). This strategy is true with research as well.

In answering the questions above, we believe there are three areas that need particular attention.

First, in a time when energy demands are increasing and existing supplies are either decreasing or creating other challenges, the ocean energy industry must move in a socially, economically, and environmentally responsible manner. This approach is key for sustainability and acceptance. Legal and regulatory best practices should be incorporated. Developers will continue to manage their way through an evolving process. Governments will continue to develop or build their expertise as they manage the ocean space and place for the public who owns it.

Second, policies will continue to be made and hopefully monitored, evaluated, and improved—policy actors and the public need to be aware and engaged. Perceptions and opinions will be changed not by pressure or force, but through trusted sources of information and communication with each audience group. At least four of the six projects reported back on this.

Third, investments in research and testing are not only sound because they bring about answers to important questions, but also because the public and others support and expect these investments. The "jury is still out" on what forms of renewable energy generation should or could be in Oregon's energy portfolio. Research and testing are important to (1) developers, for technology advancement and sound business planning; (2) policy actors and government, for innovative and effective policies; (3) stakeholders, for site selection, technology improvement, and functionality; and (4) the public, for understanding, support, and acceptance.

Some argue that both coastal and noncoastal communities would share in the benefits of electricity consumption derived from wave energy. The HDWE research program began to find answers to wave energy technology concerns in a series of human dimension issues and questions. It provided a baseline from which to start and measure change. The HDWE research program provides a snapshot in time that shows how wave energy generation off the Oregon coast was perceived during the period from 2007–2009.

Just as with wave-energy-related environmental or technical research, we are just beginning to understand the human dimension. Many areas need further investigation. Some examples of where to continue human dimension research might include:

- Compare marine renewables and land-based renewables—especially their social and economic sides (e.g., community impacts, community engagement, workforce analysis, job prediction)
- Describe lessons learned from the past regarding the connection between shore-based land-use planning and marine spatial planning
- Compare the East Coast and the

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West Coast regarding community engagement and resistance to/support for marine renewables

- Identify new audiences for outreach and engagement—both possible supporters and dissenters (e.g., nonconsumptive ocean users, urban communities)
- Design a demonstration marine renewable project jointly with a community (e.g., engineering, marketing, tourism, investment) using the lessons learned from HDWE

ACKNOWLEDGEMENTS

The authors would like to thank the other principal investigators for this research program: Michael Harte, Bryan Tilt, and Brent Steel. We would also like to thank the Oregon Wave Energy Trust and Oregon Sea Grant for their financial support. Last, but certainly not least, the authors would like to thank all of the participants in the six research projects for their time, candor, and perspectives.

REFERENCES

AEA. 2006. Review and Analysis of Ocean Energy Systems Development and Supporting Policies: A Report by AEA Energy & Environment on the Behalf of Sustainable Energy Ireland for the IEA's Implementing Agreement on Ocean Energy Systems, 59 pp. Available online at: http://www.iea-oceans.org/_fich/6/Review_Policies_on_OES_2.pdf (accessed March 3, 2010).

Bennett, J.W. 1996. *Human Ecology as Human Behavior: Essays in Environmental and Development Anthropology*, 1st ed. Transaction Publishers, New Brunswick, NJ, 387 pp.

Daigle, D. 2003. Involving the public in coastal conservation: Obstacles and opportunities. Pp. 230–238 in *Values at Sea: Ethics for the Marine Environment*. D. Dallmeyer, ed., University of Georgia Press, Athens, GA.

Delli Carpini, M., and S. Keeter. 1996. *What Americans Know About Politics and Why it Matters*. Yale University Press, New Haven, CT, 416 pp.

Gramling, R., and W. Freudenburg. 1992. Opportunity-threat, development, and adaptation: Toward a comprehensive framework for social impact assessment. *Rural Sociology* 57:216–234.

Lee, T.R. 1987. The public's view of the costs and benefits of alternative energy-systems. *Proceedings of the Royal Society of Edinburgh Section B-Biological Sciences* 92:159–171.

Huang, M.-Y., A.R.R. Janaki, D.R. Carter, and M.H. Langholtz. 2007. Is the choice of renewable portfolio standards random? *Energy Policy* 35:5,571–5,575.

Kulongoski, T. 2006. Governor Kulongoski's Action Plan for Energy. Available online at: http://www.oregon.gov/Gov/sos2006/energy.pdf (accessed March 5, 2008).

NOAA National Marine Fisheries Service. 2006. Fisheries Economics of the United States 2006. Fisheries economics and sociocultural status and trend series, NOAA Fisheries: Office of Science and Technology. Available online at: http://www.st.nmfs.noaa.gov/st5/publication/economics_communities.html (accessed July 9, 2009).

ODOE (Oregon Department of Energy). 2007. Summary of Energy Legislation Passed by the 2007 Session. Available online at: http://www.oregon.gov/ENERGY/docs/Bill_Passed_Summary.pdf (accessed March 5, 2008).

ODFW (Oregon Department of Fish and Wildlife). 2008. Estimated value ($), at the fishermen's level, of commercial fish and shellfish landings by port in Oregon, 2008. Available online at: http://www.dfw.state.or.us/fish/commercial/landing_stats/2008AnnRep/index2008.asp (accessed May 13, 2009).

Oregon.Gov. 2008. Ocean Wave Energy Development. Available online at: http://www.oregon.gov/ENERGY/RENEW/Hydro/Ocean_Wave.shtml (accessed March 1, 2009).

Simon, C.A. 2007. *Alternative Energy: Political, Economic, and Social Feasibility*. Rowman and Littlefield Publishers, Lanham, MD, 256 pp.

Stone, D.L., A.K. Harding, B.K. Hope, and S. Slaugther-Mason. 2008. Exposure assessment and risk of gastrointestinal illness among surfers. *Journal of Toxicology and Environmental Health Part A* 71(24):1,603–1,615.

Thomas, K., H.J. Dunster, and C. Green. 1981. Comparative risk perception: How the public perceives the risks and benefits of energy systems (and discussion). *Proceedings of the Royal Society A* 376:35–50, doi:10.1098/rspa.1981.0074.

United Nations. 1987. *Report of the World Commission on Environment and Development*. General Assembly Resolution 42/187, 11 December 1987. Available online at: http://www.un-documents.net/a42r187.htm (accessed March 3, 2010).