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Lessons Learned from Orkney Island:

The Possibility of Waves to Churn Out Enery and Economic Returns in the U.S.

by Marisa McNatt

About the Author

Marisa McNatt is pursuing her PhD in Environmental Studies with a renewable energy policy focus at the University of Colorado-Boulder. She earned a Master's in Journalism and Broadcast and a Certificate in Environment, Policy, and Society from CU-Boulder in 2011. This past summer, she traveled to Europe as a Heinrich Böll Climate Media fellow with the goal of researching EU renewable energy policies, with an emphasis on marine renewables, and communicating lessons learned to U.S. policy-makers and other relevant stakeholders.

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Cover: ScottishPower Renewables „Wave energy device that turns energy from the waves into electricity at the European Marine Energy Center's full-scale wave test site off the coast of Orkney Island. Pelamis P2-002 was developed by Pelamis Wave Power and is owned by ScottishPower Renewables."

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A remote island off the Northern tip of Scotland, long known for its waves and currents, is channeling attention from the U.S. and other countries for its dedication to understanding how to harness energy from these elements.

Orkney Island is home to the European Marine Energy Center (EMEC), a not for profit, private company that offers the only accredited, full-scale testing facilities for devices that turn energy from the waves and tides into electricity. As EMEC proves to be a financial success, and positive for the local and national economies, university researchers in the U.S. from the Northwest National Marine Energy Center (NNMREC), are looking to the nonprofit, and others involved in the industry in Orkney for lessons learned.

"There's more happening here than anywhere else in the world, so it's really quite exciting," says EMEC's Marketing Manager Lisa Mackenzie.

Challenges in the U.S. for building a full-scale wave power test facility

In October, Belinda Batten, Director of NNMREC, traveled to Orkney for a three-day Global Energy Symposium, part of a program of events marking the tenth anniversary of EMEC that brought wave and tidal experts from around the globe, including China, North America and Singapore for collaboration.

NNMREC currently tests scale wave and tidal devices, under the name "Pacific Marine Energy Center" (PMEC), and has plans to expand PMEC by building a test site for full-scale wave energy devices connected to the grid in Newport, Oregon.

The Department of Energy (DOE) — the department that funds NNMREC as a partnership between Oregon State University and the University of Washington — has provided initial funding for the full-scale wave test site in Newport. However, NNMREC is facing a number of hurdles before the construction phase begins, including obtaining the necessary permits from energy and environmental regulatory agencies, as well as the required funding for a full build-out.

Since the full-scale wave devices in Newport will be connected to the grid, NNMREC has to obtain a license from the Federal Energy Regulatory Commission (FERC), Batten says. FERC normally operates by having full knowledge of a project before it begins, such as knowing the specific devices that will be tested, when they will be installed and how long they will be at the site. That's not a test facility, Batten explains.

To overcome this challenge, NNMREC has been meeting with representatives from state and federal regulatory agencies to establish agreements allowing developers to install certain devices at the Newport test facility without additional permission. The devices would be subject to an adaptive monitoring framework, where devices would be monitored over time according to certain protocols, and removed from the water, or altered if they are found to have negative environmental impacts.

"By doing it this way, it will create maximum flexibility in terms of what devices we can test, and how we can get them in," Batten says.

Lessons from EMEC

In Orkney, unlike NNMREC's plan for an umbrella-permitting plan, developers connecting devices to EMEC's test berths are required to obtain individual environmental impact assessments and notify EMEC of any significant environmental interactions. At the EMEC Symposium, developers reported that there hasn't been environmental incidents, or impacts from their devices on the marine environment requiring attention —information relevant in the U.S.

"Any data that we can share with regulators is a definite step up," Batten says.

Since NNMREC devised the plan for the full-scale wave test site in 2008, the university partnership has collaborated with EMEC on various stages of the planning process. By writing a technical report based on their experience running full-scale test sites, including an analysis of port facilities, cable costs, where devices could be connected to the grid and more, EMEC helped NNMREC to choose Newport as the community for the full-scale site.

"EMEC really looks at this as a partnership of test facilities that can really help to move the industry forward. And, it's really cool to have them as a collaborator, an advisor, and they're very open and frank about what we should think about, and that's really kind of neat," Batten says.

Contracting out EMEC's 14 full-scale wave and tidal test sites that run subsea cables from each test berth in the water to a substation onshore where they meet the UK national grid, is allowing the center to become financially independent.

Previously, EMEC relied on public funding from the Scottish Government, the UK Government, the Orkney Islands Council and other public institutions. To date, about £30 million of public funding has been invested in EMEC after the House of Commons Science and Technology Committee understood the necessity of a test center to kick-start the marine renewables industry in the UK, and Orkney's potential as the site for the test center.

"The resource around Orkney is just fabulous. We've got really, really harsh conditions here," Mackenzie says.

Figure 1: Waves at the Billia Croo Wave test site at EMEC. Photo Credit: EMEC

A resource report on the U.K. territorial waters shows that Orkney, at the most northerly point of the national grid, where the Atlantic Ocean meets the North Sea, provides the most diverse wave and tidal conditions of the country's territorial waters.

At the test site for wave power devices in Orkney, the North Atlantic Ocean batters against the West Coast of Orkney, with waves averaging 6 to 9 feet, and the highest wave recorded at more than 62 feet.

Like Orkney, the wave conditions off the coast of Oregon provide an ideal environment for testing wave energy devices. During summer months, wave heights average 3 to 8 feet, and during winter months, wave heights increase to an average of 6 to 16 feet, with maximum wave heights reaching 22 to 45 feet.

Realizing the economic gains from a full-scale wave-test

Unlike EMEC, NNMREC's greatest barrier to building a full-scale wave testing facility is obtaining the necessary funding. To date, the US Department of Energy has provided NNMREC with some funds, including $4 million last year, which generated an additional $4 million in non-federal cost match, and the university partnership was recently awarded $750,000 from DOE to continue work on the planning process. To build the facility, NNMREC will need somewhere between $25 and $30 million.

Although not a small chunk of change, EMEC's experience in Orkney attests to the possibility of the PMEC grid-connected wave center becoming financially independent, and the many benefits that a testing center can bring to a community.

"What I've seen happen since this industry kind of developed, especially in the last maybe four or five years, is I think it's actually been a really, really beneficial effect on Orkney," Mackenzie says.

Unemployment in Orkney is at a low of 1.6 percent and the wave and tidal sectors now support around 250 jobs on the island and about 500 in Scotland, including employment in the supply chain, vessel support, and development. EMEC's clients are pumping about £1 million per device into the local economy.

In Orkney, the out-of-season tourism industry, from restaurants, to hotels, to caterers is now supported from workers in the marine renewables industry and travellers.

Figure 2: Graphic of the PMEC testing facilities. Wave energy developers can currently conduct limited tests at NETS, however, the site at PMEC-SETS, if constructed, would allow developers to connect utility-scale devices to the grid, provide electricity locally and meet international standards. Photo Credit: Allison Walkingshaw

"I think it's making Orkney a bit more vibrant. It attracts a lot of people to Orkney, cause they're itchin' to see what's happening," Mackenzie says.

At EMEC itself, in the last few years, the number of employees working for the Center has doubled, showing how much activity is happening around marine renewables, Mackenzie says. Of the 22 employees working for the center in 2013, one-third were living in Orkney prior to getting a job with EMEC and one-third were born and raised on the island. As an Orcadian herself, Mackenzie never expected to come back to live and work in Orkney, after graduating from Glasgow Caledonian University in 2010 with 1st class honors.

"It's perfect for me, it's exactly what I want to do. I focused on marketing and economics throughout my degree, but never imagined I'd find a job in Orkney where I could put these skills into practice," Mackenzie says.

Until NNMREC receives the necessary funding for the PMEC full-scale wave test site, the opportunities for local growth in Newport and national economic growth from the facility may literally be lost at sea.

"The Newport community is all on board with this. They sent us a proposal to put PMEC SETS (South Energy Test Site) in Newport that was like 'two thumbs up,'" Batten says.

The fishermen drew up the study area in the ocean off the coast of Newport. When NNMREC was working on the siting phase, they held town hall meetings in Newport, where all stakeholders were represented, and spoke about the economic picture of Orkney, Batten explains.

"I know that's one thing that the communities look at as a positive. So, they're very much behind the test facility," Batten says.

International development in wave energy

Countries around the world are partnering with EMEC to build, or expand their wave and tidal test facilities, capitalizing on the growth in marine renewables.

"That's quite exciting, and it's great that the UK can export this knowledge, and help with that, the development of the industry," Mackenzie says.

EMEC has five partnerships in Asia to support development of the wave and tidal industry. EMEC's most recent partnership in Singapore is providing the Energy Research Institute at Nanyang Technological University with advice on setting up a scale test facility in the country's unique climate and sea conditions. The Fundy Ocean Energy Center in Nova Scotia, Canada has also formed a strategic alliance with EMEC.

Although it remains uncertain when commercial development for wave devices will take off, wave energy developers with devices at EMEC test berths are already forming partnerships for future commercial development.

Currently, the Swedish utility company Vattenfall — one of Europe's largest generators of electricity — is partnering with wave energy developer Pelamis Wave Power that has been testing their full-scale wave energy devices at EMEC since 2004. The companies

formed the joint venture Aegir Wave Power Ltd., for developing a 10 megawatt wave farm off the coast of Shetland, an island about 50 miles northeast of Orkney.

Although the developers for Aegir project don't anticipate power to be exported from the wave farm until 2021, Vattenfall expects the venture to provide a reasonable but low economic return, and a gain in competence and credibility once wave energy technology is commercial.

"The significant global potential of wave energy is very exciting. It has, in our estimation, the potential to be a second wind industry, with all of the associated economic benefits, with less negative environmental and social impacts," says Harvey Appelbe, the Project Director for Aegir.

The full-scale test facility is critical for the U.S. to make gains in the wave industry

Figure 3: Pelamis Wave Power's P2-001 device at EMEC. Photo Credit: Pelamis Wave Power

On a national level, the U.S. may also lose out if the Newport facility is not constructed. It goes back to wind energy, Batten says. In the 70s, the U.S. along with the Danes were leaders in the wind industry, but when the funding was pulled, the U.S. dropped out, and now Danish companies are one of the primary suppliers of wind energy devices.

As wave and tidal devices move toward commercial development, the U.S. is currently in a position to be one of the companies that would provide these marine renewables nationally, and to the world. If the U.S. doesn't have a test facility, then the wave industry will develop somewhere else. Then the U.S. will import wave devices, pay for them and use them, just like what's happened with wind energy, Batten explains.

"We've got an opportunity right here, right here and right now to be part of the economic development around the industry," Batten says.

On the West Coast of the U.S. there's 250 terawatt hours per year of recoverable wave energy resources — enough power for 27 million homes. Globally, wave energy is estimated at 11,400 terawatt hours per year.

"If we've got the test facility, we could engage in really being a leader in the development," Batten says.

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