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APPENDICES

APPENDIX A: EUROPEAN MARINE ENERGY CENTRE: CASE STUDY

CASE STUDY: PENTLAND FIRTH AND ORKNEY WATERS MARINE RENEWABLE ENERGY

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Introduction

The Orkney Islands, situated off the north east coast of mainland Scotland, have become an international centre for marine renewable energy research and development in wave and tidal energy. Given that the Orkney waters boast 50% of the UK's and 25% of Europe's tidal resources, it was ideally situated to host the European Marine Energy Centre (EMEC). This case study provides a snapshot and high-level overview of the development of Orkney as a centre for marine renewable energy research and development.

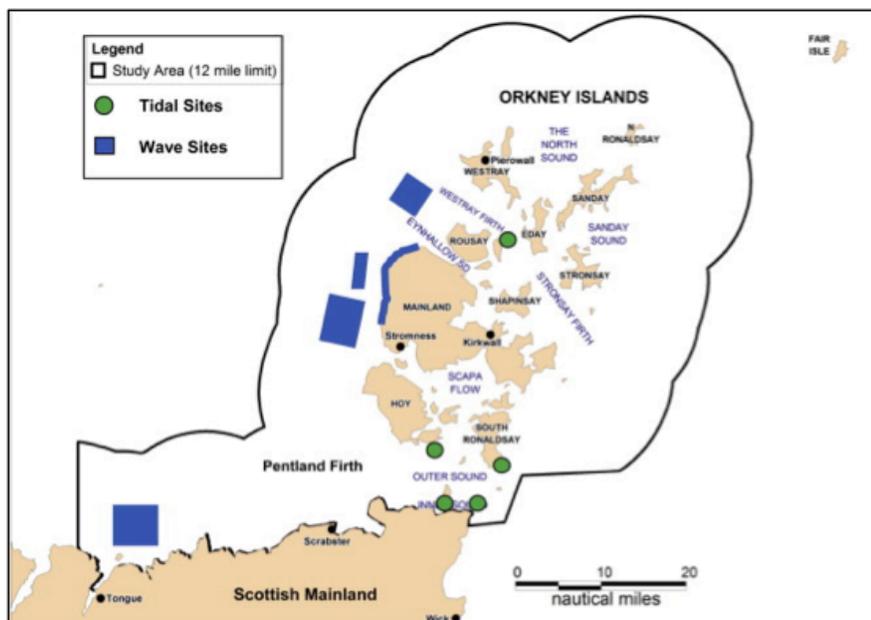
The Orkney Islands

The history of Orkney is rich and varied and spans almost 9,000 years. In the 1850s, the retreating seas uncovered Skara Brae (a UNESCO World Heritage site), an early Neolithic community. Vikings based their raids from the Orkney Islands against Scottish and Norwegian settlements, ending in 875 with formal Norwegian rule. Scottish rule of the Orkney Islands emerged in 1468 as a dowry from the King of Norway. The Orkney Islands came under British rule soon after and is now part of the United Kingdom. During the World War I and World War II, the Orkney Islands, in particular Scappa Flow, served as an important naval centre.

The people of the Orkney Islands have been opportunistic, basing their lives on a close relationship to the sea and its resources. Shipbuilding and fishing historically supported local economies and more recently farming, offshore oil and gas, and tourism. With the advent of marine renewable energy research and development, the Orkney Islands were a likely choice for this type of development. Covering an area of 975 km² comprised of 70 islands, the population is approximately 20,000 inhabitants, situated on 17 of the Orkney Islands. This number swells to 127,000 as visitors travel to these islands seasonally.

Marine Resources and EMEC

The Orkney Islands have some of the best-known marine resources in Europe and it's estimated that up to 18,000 GWh of renewable energy could be generated annually. Renewable energy resources, if fully developed on the Orkney Islands, could contribute more than the 40% that is required for the Scottish government to meet its renewable energy targets by 2020. Given the Orkney Islands abundant marine energy resources, it was the ideal location for the



European Marine Energy Centre (EMEC). Established in 2003 in Stromness, EMEC provides both research and testing of wave and tidal energy converters, including deployment methodologies and procedures. Heriot Watt International Centre for Islands and Technology (ICIT), also located in Stromness, provides research and technical expertise to the growing marine renewable energy sector. Collectively, both EMEC and ICIT have positioned the Orkney Islands as a centre of excellence in technical expertise and knowledge related to marine renewable energy. In addition to the 14 full-scale berth sites for tidal and wave-testing devices, there are two scale test sites where tidal and wave energy converters in early stages of design can be tested. EMEC also provides other services that include independently verified performance assessments as well as research and consultancy.

The straits separating the Orkney Islands from mainland Scotland are known as the Pentland Firth. It is here that EMEC has the majority of its tidal berth sites, where tidal currents can range up to 4.5 m/s. Tidal clients include, for example, Open Hydro, Atlantis Resources Corporation, Bluewater Energy Services, Scotrenewables, and Voith Hydro. Currently, EMEC has eight grid-connected tidal berth sites, with plans for expansion.

Economic Development

- Marine renewable energy has stimulated economic growth in the Orkney Islands particularly in the communities of Stromness and Kirkwall. Approximately 250 jobs have been created as a direct result of marine renewable energy development since the creation of EMEC ten years ago. These jobs span the supply chain and include, for example, engineers, metal fabricators, tidal device developers, and shipyard and quay services. The net economic impact has been significant supporting local economies significantly.
- Key to the development of the marine renewable energy sector was consultation and collaboration with ocean energy device manufacturers to determine the needs of industry. Needs included 24-hour access to ports for construction purposes, long quays, skilled labour, and a small area of land with long-term availability in the port facility. Given the momentum in marine renewable energy development, EMEC's and ICIT's positioning of Orkney as a place to do research and business, and significant investment by the Orkney Islands Council and Scottish Government, the Pentland Firth and Orkney Waters Marine Energy Park was recently established. Scotland's Energy and Climate Minister noted *"the designation as a marine energy park further promotes the Highlands and Islands of Scotland as a marine energy hub, and will accelerate investment and the industry's ambition for commercialization of the technologies being tested here."*
- Supply chain development, especially technical expertise, has been fuelled by the growth of the marine energy sector. Energy North, a trade association, has developed a supply chain matrix in consultation with its members in order to demonstrate its reach and capabilities in the marine renewables sector.

Planning

The Crown Estate manages Crown properties throughout the United Kingdom and is responsible for developing leases with developers for tidal and wave devices. Recent leases in the Pentland Firth and Orkney waters to tidal and wave device developers have the potential capacity of up to 1,600 MW. Collectively, the projects are thought to be the largest development of its kind worldwide. Gaining community support for this type of development consisted of one-week of events called Information Days. Attracting over 700 people to these events, 90% of the feedback indicated support for marine renewable energy development.

In order to accelerate and de-risk project development, the Crown Estate invested approximately \$9 million in enabling actions. A developer's forum, comprised of the developers in the Pentland Firth and Orkney waters and the Crown Estate, determined these actions. Regulatory bodies and interactions with other stakeholders

provide the Crown Estate with guidance in the application of these enabling actions.

Marine spatial planning (MSP) of the Pentland Firth and Orkney waters began in 2012 and an advisory group was established in 2013. A working group, developed by Marine Scotland, the Highland Council, and the Orkney Islands Council, is tasked with the development of the pilot non-statutory Pentland Firth and Orkney Waters Marine Spatial Plan. The aim of this strategic plan is to develop a decision-making framework for licensing and other consent applications in the marine area. To achieve this goal, it will be necessary to consult with stakeholders and “reconcile the aspirations” of the multiple users of the marine environment that includes in-shore fisheries, shipping and navigation, aquaculture, oil and gas, recreation, tourism, and the marine renewable sector. The ultimate purpose of the plan is to support sustainable economic growth and management of the Pentland Firth and Orkney waters.

The Local Development Plan for Orkney addresses a broad range of community planning issues that include policies on coastal development. Current designations for coastal areas are: developed, undeveloped and isolated coast. Development will not be allowed in areas at risk such as those with coastal erosion. The plan notes that partnerships are required to implement many of the actions. The Orkney Renewable Energy Forum, working in partnership with the Orkney Islands Council, has provided leadership in the ongoing discussion and debate regarding Orkney’s future with renewable energy and its role in marine renewable energy.

Sources

Crown Estate: Wave and Tidal

<http://www.thecrownestate.co.uk/energy/wave-and-tidal/>

Embracing Renewable Energy: The Orkney Islands

<http://ec.europa.eu/ourcoast/index.cfm?menuID=8&articleID=91>

European Marine Energy Centre

<http://www.emec.org.uk/>

Green light for £9.2m harbour pier plan

<http://www.scotland.gov.uk/News/Releases/2012/08/coplands-dock28082012>

Orkney Renewable Energy Forum

<http://www.oref.co.uk/>

Resource Analysis of the Pentland Firth

<http://www.see.ed.ac.uk/~shs/Tidal%20Stream/Draft%20Pentland%20Firth%20Resource%20Assessment%20Paper.pdf>

APPENDIX B: OCEAN RENEWABLE POWER COMPANY (ORPC): CASE STUDY

CASE STUDY: OCEAN RENEWABLE POWER COMPANY

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Company Profile and Values

Strong environmental and community values have fueled ORPC's vision of developing environmentally friendly projects that harness the power of the tides and currents of North America's coasts and rivers. ORPC has quickly emerged as a leader in marine renewable energy development and is one of the few companies in the world to have harnessed power from the water without a dam or impoundment. While the primary focus of ORPC has been on its Cobscook Bay Tidal Energy Project adjacent to the City of Eastport and Town of Lubec, Maine, it is also developing projects in Cook Inlet, Alaska and Brier Island, Nova Scotia.

Taking advantage of the 100 billion tons of water flowing in and out of the Bay of Fundy and tidal ranges reaching up to 55 feet, the City of Eastport and Town of Lubec, Maine at the mouth of the Bay of Fundy, were likely choices for tidal energy research and development by ORPC. In 2012, ORPC's tidal energy converter, called TidGen delivered power to the Bangor Hydro Electric power grid from ORPC's Cobscook Bay Tidal Energy Project. This made ORPC the first marine renewable energy company to deliver tidal energy to the grid in North America. The innovative design of TidGen, coupled with ORPC's reputation as a strong community partner, has demonstrated that marine renewable energy is not only feasible but can be done with a meaningful foundation of community engagement and a strong network of partners.

Engaging Community and Partners

Founder and CEO of ORPC, Christopher Sauer, started his company in Florida with designs to develop marine renewable energy off Florida's eastern coast. Given the distance to the resource and the high costs associated with development, Chris moved his company to Portland, Maine, where he explored other areas for tidal energy development. He was familiar with Maine, as he had a cabin he had been visiting for years. With ORPC established in Maine, the company focused its research and development on the resources in Cobscook Bay, adjacent to the City of Eastport and Town of Lubec.

ORPC takes an incremental approach to growth and this philosophy was put into practice with the Cobscook Bay Tidal Energy Project. At the outset, ORPC implanted themselves in the community by opening a local office. Engaging the community early was crucial to help overcome local skepticism. People in the City of Eastport and Town of Lubec had heard before from other developers of projects that never materialized, such as oil refineries, tidal dams, and fish farms. ORPC overcame the skepticism by working hard to become part of the community.

It was important for ORPC to do it right, get the lay of the land, and establish a good track record with the communities and other stakeholders of interest as it moved toward establishing its first project. Rather than approaching the communities and detailing its needs, ORPC noted the available opportunities with respect to tidal energy and asked how they could work together as partners in pursuing this type of development. Part of this involved developing an informal MOU with the City of Eastport. The MOU outlined how data collected by ORPC and its partners would be shared. Some of this data included information related to environmental

monitoring of benthic habitats.

Key to community engagement for ORPC is thinking long-term engagement. The company has 5 full-time staff in the City of Eastport. These people are well connected and have networked with the Cobscook Bay Resource Center, the Eastport Port Authority, Sunrise County Economic Council, the Cobscook Bay Fisherman's Association and area fishermen, local harbor pilots, The Boat School, and public and other local organizations. While ORPC has conducted open houses and hosted other public forums on tidal energy development, what has been most successful has been the time it has taken to develop one-on-one relationships with its stakeholders.

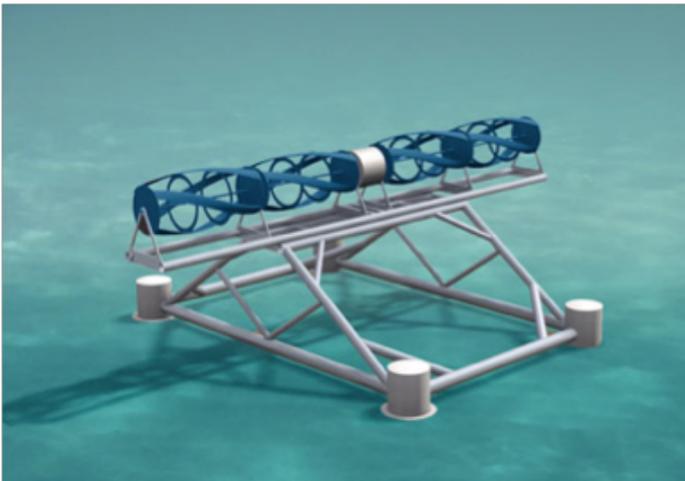
Coupled with its community efforts has been its relationship with Calypso, an innovative marketing firm that has helped ORPC craft its message. "The messaging equipped ORPC with consistent language that effectively supported and exemplified the company's leadership position" nationally and internationally. Positive press in targeted trade and professional publications as well as the popular press has positioned ORPC as a world leader in marine renewable energy technology. This type of attention is important in attracting future investment. ORPC's deep community engagement and its innovative technologies provided Calypso with a good story to tell.

Economic and Environmental Impacts

To date, the Cobscook Bay Tidal Energy Project has injected \$14 million into the local economy, \$4.7 million in the local community since 2007. ORPC, as well as having engaged 40 local contractors, have created five full-time local jobs and supported 100 supply chain jobs. This level of investment is significant and was leveraged largely through a \$10 million investment by the U.S. Department of Energy to bring ORPC TidGen from the laboratory to commercial deployment. Power generated from the Cobscook Bay Tidal Energy Project will be enough to power 75 to 100 homes. Future expansion plans will provide 5 megawatts of power, enough energy to supply power to over 1,200 homes and businesses in Maine.

ORPC is diligent in their approach to evaluating the effects of their devices on marine life. Tidal turbine devices have been monitored with cameras and other equipment to better understand the impacts on fish and sea mammals. This has been done in collaboration with universities and environmental groups. Research has shown minimal negative impacts to marine life, as it is believed fish and sea mammals tend to avoid the slow-moving turbine foils of the TidGen device. With a \$600,000 grant from the U.S. Department of Energy in 2009, ORPC has been able to monitor beluga whales in its Cook Inlet site in Alaska in order to track the consequences of the deployment of its devices.

Computer image of TidGen



ORPC Technology

The TidGen is developed to operate in depths of water from 15-30 metres, allowing it to be used in shallow tidal sites. TidGen was engineered based on principles of modularity, the use of strong materials suited for marine environments, minimal benthic impact, and low revolutions per minute (RPM). The TidGen power system "produces electricity from water currents using dual advanced design cross flow (ADCF) turbines that drive an underwater permanent magnetic generator mounted between the turbines on a common shaft. The technology features a limited number of moving parts that do not use gears or petroleum-based lubricating fluids." The TidGen, deployed at Cobscook Bay, Maine,

has a maximum capacity of 180 kW but will operate at 60 kW as tidal currents reach a maximum of 2.65 m/s. Electrical components will vary at other sites based on site characteristics. Once deployed, the device is fully submerged with no visual impact and only limited effect on local marine traffic. The TidGen is approximately 27 m long by 3 m wide by 3 m high, and the bottom support frame is approximately 20 m long by 14 m wide by 6 m high. It is connected to shore using underwater power and data cables.

Strategic Partnerships

In addition to the Cobscook Bay Tidal Energy Project, ORPC has research and development projects underway in Cook Inlet, Alaska and Brier Island, Nova Scotia. In Nova Scotia, ORPC has formed a partnership with Fundy Tidal Inc., a community-based and community-shareholder owned Canadian power company. Like the project across the Bay of Fundy in Maine, FTI and ORPC have plans to do something in the Digby Gut. As these projects come online, they will have the combined potential to generate more than 300 megawatts of electricity.

Sources

Ocean Renewable Power Company

<http://www.orpc.co/>

Business Green: US takes the plunge with first tidal energy array

<http://www.businessgreen.com/bg/news/2194474/us-takes-the-plunge-with-first-tidal-energy-array>

Can Tidal Power Create Enough Jobs To Save A Dying Town?

<http://www.forbes.com/sites/davidferris/2012/07/31/can-tidal-power-create-enough-jobs-to-save-a-dying-town/>

History of Tidal Power

<http://www.mainetidalpower.com/>

Fundy Tidal Inc.

<http://www.fundytidal.com/>

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