MEMORANDUM

From: Matthew Dunne, Acting Chief Counsel, ARPA-E

To: Carol Borgstrom, Director, Office of NEPA Policy and Compliance

Subject: Proposed NEPA Categorical Exclusion B5.25

Date: November 18, 2010

I. INTRODUCTION

The Advanced Research Projects Agency – Energy (ARPA-E) submits this memorandum in support of proposed categorical exclusion (CX) B5.25, "Small-scale renewable energy research and development and pilot projects in salt water and freshwater environments."

> *B5.25 Small-scale renewable energy research and development and pilot projects in salt water and freshwater environments*
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> Small-scale renewable energy research and development projects and small-scale pilot projects located in salt water and freshwater environments. Activities would be in accordance with, where applicable, an approved spill prevention, control, and response plan, and would incorporate appropriate control technologies and best management practices. Covered actions would not occur (1) within areas of hazardous natural bottom conditions or (2) within the boundary of an established marine sanctuary or wildlife refuge, a governmentally proposed marine sanctuary or wildlife refuge, or a governmentally recognized area of high biological sensitivity (such as protected areas and other areas of known ecological importance, whale and marine mammal mating and calving/pupping areas, and fish and invertebrate spawning and nursery areas recognized as being limited or unique and vulnerable to perturbation; these areas can occur in bays, estuaries, near shore, and far offshore, and may vary seasonally), or outside those areas if the activities would have the potential to cause significant impacts within those areas. No permanent facilities or devices would be constructed or installed. Covered actions do not include drilling of resource exploration or extraction wells, use of large-scale vibratory coring techniques, or seismic activities other than passive techniques.

The Committee on Prospering in the Global Economy of the 21st Century, which first proposed the creation of ARPA-E, envisioned an agency that would "sponsor creative, out-of-the-box, transformational . . . energy research in those areas where industry by itself cannot or will not

undertake such sponsorship, where risks and potential payoffs are high, and where success could provide dramatic benefits for the nation."[1]

Congress incorporated this vision into ARPA-E's governing statute:

> The goals of ARPA-E shall be (A) to enhance the economic and energy security of the United States through the development of energy technologies that result in (i) reductions of imports of energy from foreign sources; (ii) reductions of energy-related emissions, including greenhouse gases; and (iii) improvement in the energy efficiency of all economic sectors; and (B) to ensure that the United States maintains a technological lead in developing and deploying advanced energy technologies.[2]

Secretary of Energy Steven Chu has reiterated this vision: "ARPA-E is a crucial part of the new effort by the U.S. to spur the next Industrial Revolution in clean energy technologies, creating thousands of new jobs and helping cut carbon pollution."[3]

Consistent with its statutory mandate, ARPA-E funds projects that promote revolutionary advances in fundamental sciences, translate scientific discoveries and cutting-edge innovations into technological innovations, and accelerate transformational technological advances in areas that industry by itself is not likely to undertake because of technical and financial uncertainty.[4]

ARPA-E views the development and deployment of renewable energy technologies in the aquatic environment as critical to achieving its mission. These technologies have the potential to reduce imports of energy from foreign sources, decrease energy-related emissions, and improve energy efficiency across the board. Moreover, these technologies will enable the United States to establish and maintain a technological lead over foreign competitors.

According to the White House Council on Environmental Quality (CEQ),

> Agencies should establish new categorical exclusions to eliminate unnecessary paperwork and effort reviewing the environmental effects of actions that, absent extraordinary circumstances, do not have significant environmental effects. By establishing new categorical exclusions and using them

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[1] National Academies, *Rising Above the Gathering Storm* (2007) at 154.
[2] 21st Century Competitiveness Act, Pub. L. No. 110-69, § 5012(c)(1), 121 Stat. 572, 621 (2007) (to be codified at 42 U.S.C. § 16538) [hereinafter "America COMPETES Act"].
[3] DOE Press Release (Oct. 26, 2009), http://www.energy.gov/news2009/8207.htm.
[4] America COMPETES Act § 5012(c)(2).

appropriately, agencies can focus their environmental review efforts on proposals that warrant preparation of an EA or an EIS. . . . Federal agencies should develop and propose a categorical exclusion whenever they identify a category of actions that under normal circumstances does not have, and is not expected to have, significant individual or cumulative environmental impacts.[5]

Pursuant to draft guidance issued by the CEQ regarding the substantiation of proposed categorical exclusions,[6] ARPA-E has determined that proposed categorical exclusion B5.25 is necessary and appropriate based on (1) scientific and technical expert opinion, (2) U.S. Department of Energy (DOE) experience, (3) other Federal agency experience, and (4) foreign government and private industry experience.

II. SCIENTIFIC AND TECHNICAL EXPERT OPINION

Pursuant to draft guidance issued by CEQ, ARPA-E consulted with scientific and technical professionals regarding the potential environmental impact of small-scale and small-scale pilot renewable energy R&D projects located in aquatic (i.e., salt water and freshwater) environments.

A. Ms. Sue Barr

Remarks:

- Ms. Sue Barr was asked to comment on the potential environmental impacts of small-scale renewable energy research and development projects and small-scale pilot projects located in aquatic environments based on the current experience in the United Kingdom. She stated that renewable energy technologies, including tidal energy and offshore wind energy, have not been found to have significant environmental impact if deployed on a small scale or small pilot scale (e.g., a single device or small number of devices) in the aquatic environment.
- Ms. Barr noted that European companies and governments have deployed a wide array of renewable energy technologies in the aquatic environment, prepared numerous environmental studies and reports, and engaged in environmental monitoring over many years. She stated that none of these studies, reports, and monitoring have found any significant environmental effects when the renewable energy technologies are deployed at a small scale or small pilot scale. The policy used in the UK and Europe is one of 'deploy and monitor' which allows developers to place technologies in the aquatic

[5] Draft Guidance for Heads of Federal Departments and Agencies from Nancy H. Sutley, Chair, Council on Environmental Quality, "Establishing and Applying Categorical Exclusions under the National Environmental Policy Act" (Feb. 18, 2010), at 3.

[6] *Id.* at 5.

environment and monitor for any effects. Sue Barr stated that the environmental effects would only become potentially significant when a large number of renewable energy devices were deployed in the same area.

Qualifications:

- Ms. Barr has extensive experience in the marine industry, with key experience in project development, Environmental Impact Assessments and consenting of marine renewable projects. A degree-qualified Marine Biologist, with a M.Sc. in Environmental Management, she has first-hand experience in managing environmental assessment and the consenting process in several jurisdictions. Ms. Barr previously led the UK Government on the licensing and regulation of offshore wind developments in UK waters and latterly helped devise early policy and planning, which supported the development of wave and tidal licensing regimes and the UK Marine Bill. She contributed to the planning system for Alderney's waters and has advised several licensing bodies internationally on best practices for marine renewable energy developments.
- Since 2007, Ms. Barr has undertaken a number of key roles in managing tidal renewable energy projects for OpenHydro Group Ltd. of Ireland. She also represents OpenHydro both externally, as well as directly with the company's clients and joint-venture partners on securing consents for project development. Ms. Barr plays a key role in contributing to and driving industry policy and decision making in the marine area, in Ireland and internationally.
- Ms. Barr represents the marine renewable industry on several national level bodies including the Marine Renewables Industry Association (MRIA Ireland) and Scottish Renewables Forum (SRF) Marine Working Group. Ms. Barr also sits on the Sustainable Energy Authority technical working group for Ireland.

B. Mr. Kurt Buchholz

Remarks:

- Mr. Kurt Buchholz was asked to comment on the potential environmental impacts of small-scale and small pilot renewable energy R&D projects in the aquatic environment. He stated that renewable energy R&D projects that are deployed at a small scale and small pilot scale in aquatic environments will not have a significant environmental impact. Mr. Buchholz noted that the environmental effects would only become significant when a large number of renewable energy devices were deployed in the same area. A large number of renewable energy devices would have cumulative effects that could significantly impact the aquatic environment.

Qualifications:

- Curriculum vitae attached hereto in Appendix A-1.

C. Dr. Doug Davy

Remarks:

- Dr. Douglas Davy was asked to comment on the potential environmental impacts of small-scale and small-scale pilot renewable energy R&D projects located in aquatic environments. He stated that renewable energy technologies will not have a significant environmental impact if deployed on a small scale or small pilot scale (e.g., a single device or small number of devices). He stated that anchoring renewable energy R&D devices have only limited and localized environmental impacts.

Qualifications:

- Dr. Davy is a Program Manager with CH2M HILL's Industrial Systems Business Group in Sacramento, California. Dr. Davy has 24 years of experience providing regulatory compliance and project management support for infrastructure development projects. He has served as project manager for numerous environmental licensing and permitting projects for electrical generation and transmission projects. Project experience includes renewable energy (marine hydrokinetic, solar concentrating, solar photovoltaic, hydroelectric), electrical transmission lines, conventional power plants, and fiber optic communication lines. Most recently, Dr. Davy has served as Project Manager for licensing and permitting of Pacific Gas and Electric Company's Humboldt and Central Coast WaveConnect projects. These are the first wave energy conversion projects to be proposed by a public utility on the west coast of the United States. Dr. Davy holds M.A. and Ph.D. degrees.

D. Dr. Paul Jacobson

Remarks:

- Dr. Paul Jacobson was asked to comment on the potential environmental impacts of small-scale and small-scale pilot renewable energy R&D projects located in aquatic environments. He stated that a temporary deployment of a single renewable energy device (e.g., tidal power turbine), or a small number of renewable energy devices, in a non-sensitive area is unlikely to have a significant impact on the aquatic environment, assuming appropriate spill prevention measures are implemented.

Qualifications:

- Curriculum vitae attached hereto in Appendix A-2.

E. Dr. Louise Kregting

Remarks:

- Dr. Louise Kregting has conducted environmental studies of the potential environmental impacts of marine energy converters on coastal inshore ecosystems. The main component of cold water inshore ecosystems is large brown seaweeds (kelps), which occur in the immediate subtidal area down to 15 - 25 m.
- Dr. Kregting investigated the relationship between the growth rate and water motion of natural populations of the kelp *Laminaria hyperborea* at two aquatic sites exhibiting high and low wave energy. She determined that marine energy converters have little or no impact on the growth rate of *Laminaria hyperborea* during the summer. In addition, she determined that marine energy converters have little or no impact on the growth rate of *Laminaria hyperborea* during the winter and spring, which is the critical main growth phase of the kelp.
- Dr. Kregting stated that a single renewable energy device (e.g., tidal power turbine), or a small number of renewable energy devices, deployed in the aquatic environment is/are not likely to have a significant long term environmental impact. She noted that there might be an impact during the installation (e.g., anchoring) of the devices, which depends on the type of device.

Qualifications:

- Curriculum vitae attached hereto in Appendix A-3.

F. Mr. Dallas Meggitt

Remarks:

- Mr. Dallas Meggitt was asked to comment on the potential environmental impacts of small-scale demonstration and small-scale pilot renewable energy R&D projects located in aquatic environments. Mr. Meggitt's conclusions are based on many years of experience with designing, developing, installing and anchoring renewable energy devices in the aquatic environment and with placing and operating equipment on the seafloor, so he is familiar with the techniques for minimizing any impacts caused by the installation operations, mooring and anchoring of renewable energy devices.
- He stated that renewable energy technologies, including, but not limited to tidal energy, wave energy, offshore wind, and thermal conversion, are unlikely to have a significant environmental impact if deployed on a small pilot scale or small scale (e.g., a single device or small number of devices) using accepted siting and installation practices. He stated that anchoring or placing foundations for

renewable energy R&D devices on the seafloor or in rivers or other aquatic locations have only limited and localized environmental impacts. He further stated that the impacts on the environment are no more than those from anchoring relatively small ships or boats, and substantially less than those from bottom-contact fishing (e.g., trawling). The methodologies for minimizing or eliminating environmental impacts include careful selection of sites for the devices, accurate surveys of candidate locations, and adherence to appropriate installation techniques and established practices for the technology and site.

Qualifications:

- Curriculum vitae attached hereto in Appendix A-4.

G. Dr. Rafael Olivieri

Remarks:

- According to Dr. Rafael Olivieri, renewable energy R&D projects that are deployed at a small-scale and small pilot-scale in aquatic environments are not expected to have significant environmental impacts, assuming the project complies with applicable requirements as to effluents, sensitive habitats, cables and other structures, and sound generation.
- Dr. Olivieri stated that the environmental effects could become significant when a large-size project (either a single large renewable energy device, or a large number of smaller renewable energy devices) is deployed in the same area. A large-size renewable energy project is expected to have cumulative effects that could result in significantly impacts to the aquatic environment. However, large projects located in aquatic environments may also have unplanned secondary positive ecological effects such as providing additional surface area for benthic species, providing protected habitat for juveniles of multiple species, and acting as fish attracting device. These secondary positive ecological effects could help augment local commercial and recreational fisheries, which would be beneficial to local communities.

Qualifications:

- Curriculum vitae attached hereto in Appendix A-5.

H. Dr. Graham Savidge

Remarks:

- Dr. Graham Savidge was asked to comment on the potential environmental impacts of small-scale and small pilot-scale renewable energy R&D projects located in marine environments. He stated that a

single, small-scale renewable energy device (e.g., tidal power turbine), or a small number of such renewable energy devices, deployed in the marine environment would be very unlikely to have a significant impact on the marine environment, including marine mammals. Dr. Savidge stated that the environmental effects might become significant when a large number of renewable energy devices were deployed in the same area. A large number of renewable energy devices could have cumulative effects that may significantly impact the aquatic environment.

- Dr. Savidge noted that renewable energy R&D projects may have positive benefits for the aquatic environment. The deployment of a number of renewable energy R&D devices in a particular area would necessitate a reduction or cessation of fishing activities in that area, which may facilitate the growth of aquatic organism populations.

Qualifications:

- Dr. Savidge was appointed Lecturer in Marine Biology at the School of Biological Sciences in Queen's University Belfast (QUB) in 1974 and promoted to Reader in 1997. Until approximately 2000, his research focused strongly on biological oceanography, particularly the relationships between primary production, nutrient and light availability and mixing processes. The various studies were supported by eleven major research grants and resulted in the publication of more than thirty publications and reports. Between 1989 – 1999 he was particularly involved in the UK Biochemical Ocean Flux Study (BOFS) and Plankton Reactivity in the Marine Environment (PRIME) project, which were components of the international Joint Global Ocean Flux Study (JGOFS) Program. Oceanographic studies were carried out in the North-East Atlantic, Indian and Southern Oceans and he acted as Principal Scientist for four major research cruises including *RRS Discovery* PRIME Project Cruise 211.
- Since approximately 2000, Dr. Savidge's research has re-focused on applied macroalgal studies and the environmental consequences of marine, particularly tidal, energy extraction. UK Natural Environment Research Council (NERC) and local Northern Ireland funding supported a project which successfully demonstrated for a local sewage treatment works the feasibility of using macroalgae on a large scale to remove nutrients from treated sewage waste. University Initiative Funding has been received in conjunction with Dr. Bjoern Elsaesser (QUB) for a project starting in November 2010 to investigate the use of macroalgae cultured on rafts to remove nutrients from sewage waste entering coastal waters through outfall diffusers. Dr. Savidge is also closely involved with local initiatives investigating the possibility of using macroalgae commercially as an energy source for methane production via anaerobic digestion. In relation to this he has recently completed a project with Envision Ltd, funded by the Marine Institute, Galway, which has demonstrated the use of acoustic techniques for the assay of kelp biomass for sustainable exploitation.
- Dr. Savidge's research on the environmental consequences of marine energy extraction has had two foci. Major funding through the SuperGen 2 project funded by the UK Engineering and Physical Sciences Research Council has allowed a very substantive investigation with Dr B Elsaesser (QUB) of the

influence of wave exposure on kelp growth rates. The investigation emphasized the use of detailed estimators of wave and current activity, as derived from Acoustic Doppler Current Profiler (ADCP) measurements, for relating physical factors to kelp responses. Publications from this project are in preparation.

- The second strand of marine energy research has depended on his acting as coordinator of the QUB input to the environmental monitoring program required for the deployment of the world-leading SeaGen tidal turbine. This has been a major project and has involved initiation and co-ordination of long-term observations of seal, porpoise and seabird activities, and benthic communities as well as detailed ADCP measurements. The project has required regular presentation of progress reports as well as liaising with project supervisory and consultative groups with publication preparation planned for the end of these aspects of the project in 2011. Both strands of marine energy research have led to extensive international linkages through invited attendances and presentations at conferences and workshops including to the National Oceanic and Atmospheric Administration's Workshop on Environmental Effects of Tidal Energy Development, Seattle, 22 – 24 March 2010 and the 3rd Taiwan-UK Marine Energy R&D Scoping Workshop, Taiwan, 23 – 27 August 2010. Dr. Savidge is also a Contributing (Senior) Editor for the international journal *Marine Ecology Progress Series.*

I. Dr. Stephen Shaner

Remarks:

- Dr. Stephen Shaner was asked to comment on the potential environmental impacts of small-scale and small pilot renewable energy R&D projects in the aquatic environment. He stated that renewable energy R&D projects that are deployed at a small scale and small pilot scale in aquatic environments -- for example, a single offshore wind turbine or a small number of wind turbines -- will likely not have a significant environmental impacts, to the extent that an Environmental Assessment or Environmental Impact Statement would be required, assuming the project team obtains the proper permits and complies with applicable permitting requirements. Dr. Shaner stated that large-scale renewable energy projects involving the commercial deployment of energy technologies are more likely to potentially have significant environmental impacts, which would require either an EA or EIS.

Qualifications:

- Curriculum vitae attached hereto in Appendix A-6.

J. Dr. Jonathan Side

Remarks:

- Professor Jonathan Side was asked to comment on the potential environmental impacts of small-scale and small pilot-scale renewable energy R&D projects located in aquatic environments. He stated that a single renewable energy device (e.g., tidal power turbine) deployed in the marine environment is unlikely to have a significant environmental impact. Professor Side stated that the environmental effects were more likely where a large number of renewable energy devices were deployed in the same area. Whether a large number of renewable energy devices could have cumulative effects that may result in significant impacts on the marine environment is a matter of ongoing scientific research.
- Professor Side stated that concerns raised about possible marine mammal entanglement with the moorings of wave energy devices located in marine environments have not been supported by environmental studies and scientific data.
- Professor Side stated that the noise generated by the operation of renewable energy devices located in marine environments is much lower than background noise from other maritime traffic, though during installation activities may be comparable depending on the installation methods used.
- Finally, Professor Side noted that renewable energy R&D projects in marine environments may result in the closure of certain areas to fishing, which may not benefit the fishing industry but could facilitate the growth of certain fish populations by providing a refuge.

Qualifications:

- Professor Side is the Director of the International Centre for Island Technology (ICIT), which is part of Heriot-Watt University's prestigious Institute of Petroleum Engineering. He was Head of the Safety/Policy Section of the Institute of Offshore Engineering before leading the establishment of ICIT as its Director in 1989. He has a first class honors degree in Marine Biology and a PhD in Marine Resource Management from Heriot-Watt University. Dr. Side is a Fellow of the Royal Institution of Chartered Surveyors (RICS) and was responsible for the design and development of the MSc course in Marine Resource Management that is accredited by the RICS, and for the MSc courses in Renewable Energy Development, and Marine Renewable Energy.
- Professor Side's research interests are centered around environmental conflicts and conflicts between sea-users. He has been responsible for a number of research awards and industrial contracts from a wide range of industry, government and EU sources. Current research is focused on the environmental effects of marine renewable energy technologies.

III. DOE EXPERIENCE

Recent DOE experience with renewable energy R&D activities in aquatic environments demonstrates that proposed CX B5.25 is appropriate.

A. DOE Report on Renewable Energy R&D Projects in Aquatic Environments

In December 2009, DOE's Wind and Hydropower Technologies Program (WHT Program) submitted a comprehensive report to Congress on the potential environmental impacts of emerging marine and hydrokinetic renewable energy technologies.[7] The WHT Program based its report on peer-reviewed literature, project documents, domestic and foreign environmental assessments, and input from technology developers, non-governmental organizations, and other Federal agencies. The WHT Program assessed the full range of environmental impacts that emerging renewable energy technologies may have on aquatic environments, fish and fish habitats, ecological relationships, and other marine and freshwater aquatic resources. The WHT Program noted that "the environmental effects of [renewable energy] technologies are a function of both project design and site conditions,"[8] and concluded that "small projects sited in non-sensitive areas may not require extensive [environmental] studies" for project implementation.[9] The WHT Program found that "small deployments are likely to have small, localized impacts."[10] This finding comports with established scientific understanding that small-scale hydrokinetic facilities, such as small-scale wave energy installations, are "likely to have minimal environmental impacts."[11] By contrast, the WHT Program determined that more comprehensive environmental review would be appropriate for large-scale projects.[12]

Proposed CX B5.25 is consistent with the WHT Program's distinction between small-scale and pilot-scale renewable energy R&D activities, on the one hand, and large-scale renewable energy activities, on the other hand. By its terms, the proposed categorical exclusion is limited to small-scale and pilot-scale renewable energy R&D activities.

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[7] According to the Federal Energy Regulatory Commission, "[h]ydrokinetic projects generate electricity from the motion of waves or the unimpounded flow of tides, ocean currents, or inland waterways." FERC, "Licensing Hydrokinetic Pilot Projects" (April 14, 2008), at 1, http://www.ferc.gov/industries/hydropower/indus-act/ hydrokinetics/pdf/ white_paper.pdf, [hereinafter "FERC White Paper"].

[8] U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy (EERE), "Report to Congress on the Potential Environmental Effects of Marine and Hydrokinetic Energy Technologies" (Dec. 2009), http://www1.eere.energy.gov/windandhydro/pdfs/doe_eisa_633b.pdf, at iii-iv [hereinafter "EERE Report"].

[9] *Id.* at iv.

[10] *Id*. at 65.

[11] Robin Pelc & Rod Fujita, "Renewable Energy from the Ocean," 26 Ocean Policy 471, 475 (2002).

[12] EERE Report, *supra* note 8, at 65.

B. DOE Use of Categorical Exclusions for Renewable Energy R&D Projects in Aquatic Environments

DOE has used categorical exclusions for several renewable energy R&D projects in aquatic environments.

1. Advanced Water Power Program - Free Flow Power Corp.

DOE recently funded a marine renewable energy R&D project under the Energy Efficiency and Renewable Energy Program's (EERE) Advanced Water Power funding opportunity (DE-FOA-0000069). EERE provided a grant to Free Flow Power Corp. (FFP) to design, implement, and test an electrically interconnected, hydrokinetic turbine pylon installation to achieve maximum water-to-wire efficiency. Field testing is proceeding in two phases. Currently in Phase I, FFP plans to deploy a 3-meter hydrokinetic turbine affixed to a floating mount in the Mississippi River, tethered to a near-shore mooring. The 3-meter hydrokinetic turbine has yet to be deployed. In Phase II, FFP will deploy an in-water test mooring system, utilizing river bottom driving monopoles, anchored at a depth of approximately 30 feet below the river floor. All project work is to be carried out in accordance with (1) a nationwide permit issued by the U.S. Army Corps of Engineers for deployment of scientific measurement devices in jurisdictional waters, (2) species and habitat protection objectives set forth under the Endangered Species Act, including inter-agency consultation requirements, and (3) a preliminary project permit issued by the Federal Energy Regulatory Commission (FERC). EERE determined that the project appropriately fit into two categorical exclusions presently contained within Subpart D of DOE's NEPA Regulations (10 C.F.R. part 1021): CX B5.1 (renewable energy R&D and pilot projects) and CX A9 (Research, data analysis, information gathering and dissemination, and document preparation).

2. Advanced Water Power Program - Columbia Power Technologies LLC

EERE provided a grant to Columbia Power Technologies LLC to optimize, demonstrate, and validate an intermediate-scale wave energy conversion device called the Direct Drive Wave Energy Buoy in preparation for a full-scale offshore demonstration. Testing is proceeding in two phases, at different scales. Currently, in Phase I, Columbia Power is testing a 1:15 scale optimized energy buoy within a land-based wave tank to validate new performance estimates and numerical models. The purpose of this phase is to test system hydrodynamics and advanced controls to best capture energy in the wave regime. In Phase II, Columbia Power will deploy a 1:5 scale energy buoy for approximately 2-4 months in Puget Sound, near Seattle, Washington. The Direct Drive Wave Energy Buoy, which has yet to be deployed, will be located approximately 0.5 miles east of Puget Sound commercial shipping lanes, anchored by 7 ton weights to the seafloor. Renewable wave energy will power the buoy with a maximum of 1.4 kW, though there will be no grid connection to the buoy.

All project work is to be carried out in accordance with (1) a nationwide permit issued by the U.S. Army Corps of Engineers for deployment of scientific measurement devices in jurisdictional waters, (2) species and habitat

protection objectives set forth under the Endangered Species Act, including inter-agency consultation requirements, and (3) applicable state and municipal operating permits. EERE determined that the project appropriately fit into two categorical exclusions presently contained within Subpart D of DOE's NEPA Regulations (10 C.F.R. part 1021): CX B3.6 (small scale pilot project) and CX A9 (Research, data analysis, information gathering and dissemination, and document preparation).

3. Maine Tidal Power Initiative – University of Maine

DOE recently granted a categorical exclusion for work performed by the University of Maine under a Congressionally Directed Project, the Maine Tidal Power Initiative. As currently funded, the project seeks to develop baseline resource and environmental data for the Cobscook Bay and Western Passage in Maine to evaluate the approach for future tidal power applications. In addition to computer simulation, modeling, surveying, and monitoring, the Maine Tidal Power Initiative includes deployment of a pre-commercial test turbine in Cobscook Bay. The prototype turbine generation unit has been mounted on a work barge anchored off the shore of Eastport, Maine, using four mooring lines. The generation unit has been deployed approximately 14 feet below the water and is expected to run for six months, charging batteries for the off-shore U.S. Coast Guard fleet. Mounted on the unit are four cameras that continuously record the surrounding environment so as to document how the local fauna react to the turbine. This allows real time aquatic-take numbers to be compiled. If takings reach an unacceptable number, the project will be stopped, and the turbine will be removed from its present location. All project work is to be carried out in accordance with (1) an individual permit issued by the U.S. Army Corps of Engineers for deployment of the pre-commercial test turbine, (2) species and habitat protection objectives set forth under the Endangered Species Act, including inter-agency consultation requirements, and (3)a preliminary permit issued by FERC. EERE determined that the project appropriately fit into four categorical exclusions presently contained within Subpart D of DOE's NEPA Regulations (10 C.F.R. part 1021): CX B3.1 (Environmental monitoring), CX B3.3 (Research related to conservation of fish and wildlife), CX B3.6 (Small scale research and pilot projects) and CX A9 (Research, data analysis, information gathering and dissemination, and document preparation).

IV. OTHER FEDERAL AGENCY EXPERIENCE

Other Federal agencies have critical experience with renewable energy R&D activities in aquatic environments. In particular, the Federal Energy Regulatory Commission (FERC) and the U.S. Navy have engaged in oversight of pilot-scale marine and hydrokinetic projects which were determined to have no significant environmental impacts. Their experience confirms that proposed CX B5.25 is appropriate.

A. FERC Hydrokinetic Program

FERC maintains exclusive jurisdiction to issue licenses for the construction and operation of pilot-scale hydrokinetic energy projects in freshwater and salt water environments. As a condition of project licensing,

FERC undertakes an Environmental Assessment of every proposed pilot-scale project.[13] FERC licenses impose siting and duration restrictions comparable to those found in proposed CX B5.25. For example, FERC-licensed pilot-scale projects are authorized only for temporary terms not to exceed 5 years.[14]

FERC has issued Findings of No Significant Impact (FONSIs) for the pilot-scale hydrokinetic projects it has licensed to date.

1. Finavera Renewables Ocean Energy (Makah Bay, Washington)

Licensed by FERC in December 2007, Finavera Renewables Ocean Energy Ltd. proposed to demonstrate the economic and environmental benefits of wave energy conversion. The project was to be located in Makah Bay, approximately two nautical miles off the coast of Clallam County, Washington. The project involved the deployment of four 250-kilowatt (kW) steel wave energy conversion buoys called AquaBuoys. The AquaBuoys were to be connected to a mooring/anchoring and electrical connection system in Makah Bay, which would be further connected to a shore station by a 3.7-mile-long direct current (DC) submarine transmission cable. The shore station, in turn, was to connect to a nearby public utility district distribution line owned and operated by the county, which provides an average annual power supply of approximately 1,500 megawatt-hours (MWh).[15]

In accordance with agency licensing procedures, FERC performed a comprehensive Environmental Assessment of the project. FERC analyzed a wide array of pertinent environmental and social considerations: geology and soil resources; water resources; water fishery resources; marine mammals, reptiles, and seabirds; terrestrial resources; threatened and endangered species and essential fish habitats; recreation, ocean use, and land use; aesthetic resources; socioeconomic resources; cultural resources; developmental resources; and project decommissioning. Based on this Environmental Assessment, FERC issued a FONSI for the project in May 2007. FERC determined that the Makah Bay project would result only in (1) minor, localized effects to fish, marine mammals, and seabirds located within the vicinity of the nearby Olympic Coast National Marine Sanctuary, (2) minor reductions in the area available for commercial and recreational fishing, (3) some alteration of the aesthetic quality of Makah Bay, and (4) minor degradation of the experience of people visiting and recreating in Makah Bay.[16]

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[13] According to FERC, "pilot projects are small, short-term, removable, and carefully-monitored projects intended to test technologies, sites, or both." FERC White Paper, *supra* note 7, at 1.

[14] *Id.* at 13.

[15] FERC, Project No. 12751, Order Issuing Conditioned Original License, Makah Bay Offshore Wave Energy Pilot Project (Dec. 21, 2007).

[16] FERC, Project No. 12751, Environmental Assessment for Hydropower License, Makah Bay Offshore Wave Energy Pilot Project (May 31, 2007).

Finavera was unable to proceed with the project for financial reasons. As a result, Finavera surrendered its hydrokinetic pilot project license back to FERC in February 2009.

References:

- Cited items available in FERC eLibrary: http://elibrary.ferc.gov/idmws/search/fercgensearch.asp (Search docket No. P-12751 and include proper date range to search for documents).

2. City of Hastings (Hastings, Minnesota)

Licensed by FERC in December 2008, the City of Hastings, Minnesota, proposed to install two hydrokinetic turbines manufactured by Hydro Green Energy LLC 50 feet downstream of the City's existing powerhouse containing two 2.2 MW hydroelectric generating units. The hydrokinetic array, which is already operating, consists of two 35-kW hydrokinetic turbines suspended below a 68-foot-wide and 40-foot-long floating barge and two generating units that sit atop the barge. The barge is tethered to the dam structure and anchored for stability using anchors and spuds (piles). In addition, the barge is connected to an existing transmission line at the powerhouse.[17]

In accordance with agency licensing procedures, FERC performed a comprehensive EA of the project, assessing a wide variety of environmental and social considerations: geological and soil resources, water resources, aquatic resources, terrestrial resources, threatened and endangered species, cultural and historic resources, recreation, land use and aesthetics. Based on its Environmental Assessment, FERC issued a FONSI for this project in September 2008. FERC determined that installation and operation of the two hydrokinetic turbines at the existing hydroelectric project would have no adverse effects on geology or soils, wildlife habitat, recreation, cultural or historic resources, land use, or aesthetics. Further, FERC determined that the project's effects on water quality, fish, and nearby diving birds are likely to be minor, and that the project is not likely to adversely affect a federally listed endangered species in the area (the Higgins' eye pearlymussel). FERC found that the Hastings hydrokinetic pilot project was a good "opportunity to test, on a relatively small scale, an emerging renewable technology." [18]

A post-operational study conducted in 2009 regarding the effect of the Hastings' hydrokinetic turbines on fish populations confirmed that the Hastings hydrokinetic power unit is extraordinarily fish friendly. Only one out of 402 fish that were introduced into the hydrokinetic unit showed evidence of direct physical harm,

[17] FERC, Project No. 4306, Order Amending License, Mississippi Lock and Dam No. 2 Hydrokinetic Project (Dec. 13, 2008).
[18] FERC, Project No. 4306-017, Environmental Assessment for Installation of Hydrokinetic Turbines, Mississippi Lock and Dam No. 2 Hydrokinetic Project (Sept. 26, 2008), at 54.

establishing a 99% survival rate for the system and validating the pre-installation computer modeling used in the EA process.[19]

References:

- Environmental Assessment / FONSI available in FERC eLibrary: http://elibrary.ferc.gov/idmws/search/fercgensearch.asp (Search docket No. P-4306 and include proper date range to search for documents).
- Hastings Fish Study available at http://www.hgenergy.com/Hastings%20Agencies%20Review%20Draft%2012-21-09.pdf.

B. U.S. Navy (Kaneohe Bay, Hawaii)

Since 2004, the U.S. Navy has partnered with a private firm, Ocean Power Technologies Inc. (OPT), to engage in the phased installation and operational testing of wave energy conversion "PowerBuoys" at the U.S. Marine Corps Base Hawaii (MCBH) at Kaneohe Bay, Hawaii. Anchored in 100 feet of water approximately 0.75 nautical miles from shore, OPT's PowerBuoy consists of a floating structure with a fixed component and a movable component that is driven by wave motion. The relative motion of the buoy is used to drive electromechanical energy converters. Mechanical energy generated from the up-and-down motion of the buoy is converted into electrical energy, which is transmitted to shore by means of an armored and shielded undersea power cable. Once the cable reaches land, the electricity is routed to the existing MCBH electrical grid system. Currently, each PowerBuoy can produce an average of 20 kW of power, with a peak output of 40 kW. OPT is in the process of developing a 150 kW PowerBuoy.[20]

In order for the Navy to provide testing facilities and oversight for this project, the Office of Naval Research (ONR) prepared an EA in 2003.[21] In its assessment, ONR identified the following resources and activities for analysis under NEPA: shoreline physiography, oceanographic conditions, marine biological resources, terrestrial biological resources, land and marine resource use compatibility, cultural resources, infrastructure, recreation, public safety, and visual resources. ONR determined that none of these resources and activities would be significantly affected by the proposed installation and operational testing. In particular, the Navy

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[19] *See* Normandeau Associates, An Estimation of Survival and Injury of Fish Passed Through the Hydro Green Energy Hydrokinetic System, and a Characterization of Fish Entrainment Potential at the Mississippi Lock and Dam No. 2 Hydroelectric Project (Final Report) (Dec. 2009), at ES-2, http://www.hgenergy.com/Hastings%20Agencies%20Review% 20Draft%2012-21-09.pdf; Hydro Green Energy, Hastings, MN Project, Hastings Fish Study, http://www.hgenergy.com/hastings_fish_study.html .

[20] Mirko Previsic, "The Technology: Wave Energy Development on the West Coast," *in* Ecological Effects of Wave Energy Development in the Pacific Northwest (Boehlert, McMurray & Tortorici eds. 2007), at 19; Ocean Power Technologies, Project at Marine Corps Base Hawaii (MCBH), http://www.oceanpowertechnologies.com/projects.htm.

[21] U.S. Department of the Navy, Environmental Assessment for Proposed Wave Energy Technology Project, Marine Corps Base Hawaii, Kaneohe Bay, Hawaii (Jan. 2003).

found that the electricity conversion and transmission system would have only minor, transient effects on marine life and nearby divers.[22] ONR also determined that the acoustic energy produced by the system was not of an amplitude or frequency that was likely to have a significant impact on marine animals in the surrounding environment.[23] In addition, the Navy concluded that the hydraulic rock drilling would be well below a level of sound detection that would adversely affect any marine species.[24] Finally, ONR determined that, by avoiding areas of rich biological diversity and high coral coverage, the installation procedures were adequately designed to minimize impacts on living coral and benthic communities.[25]

References:

- Please see Appendix B-1 to review Office of Naval Research Environmental Assessment / FONSI.

V. U.S. INDUSTRY EXPERIENCE

The United States generally lags behind foreign competitors in the development and deployment of renewable energy technologies in aquatic environments. However, some U.S. companies have developed and deployed renewable energy technologies on a small scale and/or pilot scale in aquatic environments. Their experience confirms that proposed CX B5.25 is appropriate.

A. Verdant Power, LLC – Roosevelt Island Tidal Energy Project (United States)

Verdant Power LLC, a renewable energy firm with operations in the United States and Canada, is currently in the process of carrying out the Roosevelt Island Tidal Energy (RITE) Project, a six-turbine, kinetic hydropower demonstration project in New York City's East River. Initiated in 2002, the RITE Project is proceeding through Phase 3 of testing and evaluation. If successful, the project will result in the commercial deployment of a full-scale Free Flow System of turbines that will deliver electricity to approximately 8,000 homes.[26]

In Phase 2 of the Demonstration Project (2006-2008), Verdant Power and the New York State Energy Research and Development Authority (NYSERDA) established and implemented an environmental monitoring program to identify the impacts of the six-turbine array on the local environment, covering approximately 9,000 hours of operation. Monitoring activities included the operation of an array of fixed underwater hydroacoustic sensors to analyze the turbine field for underwater activity, on-vessel mobile fish monitoring in the project

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[22] *Id*. at 2-19.
[23] *Id*. at 2-19 and 4-7.
[24] *Id.* at 2-19 and 4-3.
[25] *Id.* at 4-3 and 4-20.
[26] New York State Energy Research and Development Authority (NYSERDA), Environmental Monitoring, Evaluation & Protection, Roosevelt Island Tidal Energy (RITE) Environmental Assessment, Summary Sheet (2009), http://www.nyserda.org/programs/environment/EMEP/project/9892/alternative_energy_9892.pdf.

area, and a characterization and analysis of the river's benthic habitat. These monitoring activities showed no observed evidence of increased fish mortality or injury as a result of turbine operation, nor any irregular bird impacts in the project area. The data demonstrated that fish avoid zones of impact with Verdant Power's system and populate inshore areas.[27] Verdant Power and NYSERDA's environmental monitoring program indicates that, at its current scale, the RITE project does not significantly impact the surrounding environment.[28]

References:

- Draft Environmental Report for FERC License Application, including monitoring data, available at http://www.theriteproject.com/Documents.html (See Volume 2, Parts 1-3).

VI. FOREIGN GOVERNMENT AND FOREIGN INDUSTRY EXPERIENCE

Foreign governments and foreign industry have been developing and deploying renewable energy technologies in aquatic environments for decades, so they have critical insight into actual and potential environmental impacts. Their collective knowledge and experience has inspired new designs and new methodologies for eliminating or minimizing environmental impacts, and facilitated the rapid expansion of renewable energy technologies in aquatic environments. For example, nearly 200 offshore wind turbines, with a combined power generating capacity of 577 MW, were connected to the grid in Europe in 2009. This represents a growth rate of 54% compared to the 373 MW installed in 2008. Over 2000 MW of installed generation capacity is connected to the grid today, and more than 100 GW of projects are at various stages of planning.[29] Foreign governments' and foreign industry's historic and continuing experience with renewable energy technologies in aquatic environments demonstrates that proposed CX B5.25 is appropriate.

A. Overview of Foreign Environmental Reviews

The United States was the first country in the world to require assessment of the potential environmental impact of government-directed and -sponsored projects and actions. Since the enactment of NEPA in 1970, other countries have modeled their environmental legislation and regulatory regimes on the U.S. system, adopting environmental assessment requirements comparable to those of the United States.

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[27] Verdant Power, Environmental Monitoring, http://verdantpower.com/what-environmonitor/; *see also* NYSERDA, *supra* note 26.

[28] *See generally* Roosevelt Island Tidal Energy Project, Draft Environmental Report for FERC License Application (Nov. 2008), http://www.theriteproject.com/Documents.html (Volume 2, Parts 1-3).

[29] European Wind Energy Association, The European Offshore Wind Industry – Key Trends and Statistics 2009 (Jan. 2010), http://www.ewea.org/fileadmin/emag/statistics/2009offshore/pdf/offshore%20stats%2020092.pdf.

Canada, Belgium, Chile, Denmark, and the United Kingdom — countries which have sponsored and/or authorized renewable energy projects in aquatic environments that are discussed in this memorandum — have established environmental assessment systems similar to NEPA. Each of these countries requires environmental reviews for aquatic-based renewable energy projects subject to regulatory authorization, though some have consolidated the two-tier review under NEPA (environmental assessments and environmental impact statements) into a single, comprehensive environmental review. Within these countries, environmental reviews are generally conducted by third parties or regulatory authorities, and serve as the basis upon which project authorization may be granted or denied.

Country	**Environmental Assessment Equivalent**	**Environmental Impact Statement Equivalent**
BELGIUM • *Flanders*	A *Milieu Effecten Rapport* (MER), which translates roughly as "Environmental Impact Statement" or "Environmental Impact Report," is required for projects subject to regulatory authorization where either mandated under EU or Belgian law or where the relevant government authority determines, based on screening, that a project is likely to have a significant effect on the environment. The MER is prepared by a governmentally licensed expert in the relevant field. The MER analyzes : • The areas which may be potentially affected by the proposed project; • The motives and purpose of the proposed project; • The potential environmental effects of the proposal within defined categories, such as human health, biodiversity, natural resources, etc.; • Potential mitigation measures that can be taken to avoid or mitigate serious negative effects on the environment; • Potential monitoring and evaluation measures that can be implemented to minimize project effects; and • Potential environmentally-protective alternatives, contrasted against the proposal itself. A proposed project for which a MER is prepared may not proceed until the MER is reviewed and approved by the cognizant government authority. Upon approval, the MER is made publically available by the relevant permitting agency.	

CANADA • *Nova Scotia* • *British Columbia*	Under federal law, an Environmental Assessment (EA) is required prior to project implementation for projects in which a federal agency is a key proponent, provides federal funds, grants access rights to or sells federal land, or provides regulatory authorization. If falling into a prescribed class or category of project, or if deemed likely to have significant adverse environmental effects by a responsible authority, the project must undergo a Comprehensive Study, which analyzes: • The areas affected by the project and purposes of project • Aspects of environment which could be affected by the project • Likely significant environmental effects resulting from the project • Public comments received during a public comment period • Proposed mitigation measures to prevent, reduce and offset potentially significant adverse effects • Main alternatives considered by the applicant and rationale for selected action A proposed project for which a Comprehensive Study is prepared may not proceed until the responsible authority has determined that the project is likely to cause significant adverse environmental effects that cannot be justified under the circumstances. Separately, Canadian provinces may also require an EA for a proposed project to proceed. The scope and procedures applicable to provincial Environmental Assessments vary. However, where a proposed project is deemed likely by the responsible provincial authority to have significant adverse environmental effects, each province requires preparation of a comprehensive Environmental Assessment report akin that required by federal law (though not called a "Comprehensive Study").	
CHILE	*Declaración de Impacto Ambiental* (DIA) is a certified assessment prepared by an independent party demonstrating a proposed project subject to regulatory consent will not have any of the following major impacts: • Adverse effect on public health • Significant adverse effect on renewable natural resources • Adverse effects on human communities • Adverse effect on populated areas, resources, protected areas, or conservations sites • Significant alteration of landscape • Adverse effects on cultural heritage sites A proposed project for which a DIA is prepared may not proceed until the DIA is approved by the appropriate regional or national environmental authorities.	*Estudio de Impacto Ambiental* (EIA), which translates roughly as "Environmental Impact Statement," is a comprehensive environmental assessment prepared by an independent party for a proposed project subject to regulatory consent which is likely to have one or more major impacts. The EIA assesses: • The area(s) affected by the project • Potential environmental impacts of the project • Proposed mitigation and compensation measures • Compliance with the substantive regulatory requirements applicable to the project A proposed project for which a EIA is prepared may not proceed until the EIA is approved by the appropriate regional or national environmental authorities.
DENMARK	A *VVM-redegørelse*, which translates roughly as "Environmental Impact Statement," is required for projects subject to regulatory authorization where either mandated under EU or Danish law or where the relevant authority determines, based on screening, that a project is likely to have a significant effect on the environment. The *VVM-redegørelse* may be prepared by an independent party or the governmental authority charged with authorizing a project. The *VVM-redegørelse* analyzes: • The areas which may be potentially affected by the project and the nature of the project in terms of proposed activity, size, and materials used • Aspects of environment which could be significantly affected by the project • Likely significant environmental effects resulting from the project	

	• Proposed mitigation measures to prevent, reduce and offset potentially significant adverse effects • Main alternatives considered by the applicant and rationale for selected action • Potential monitoring and evaluation measures that can be implemented to minimize project effects A proposed project for which an EIS is prepared may not proceed until the EIS is reviewed and approved by the government authority responsible for project authorization.
UNITED KINGDOM • *England / Wales* • *Scotland* • *Northern Ireland*	An Environmental Statement (ES) is required for projects subject to regulatory authorization where either mandated under EU or UK law or where the relevant government authority determines, based on screening, that a project is likely to have a significant effect on the environment. The ES must be prepared by a suitably qualified consultant or professional based on a comprehensive Environmental Impact Assessment (EIA). The ES analyzes: • The areas which may be potentially affected by the project and the nature of the project in terms of proposed activity, size, and materials used • Aspects of environment which could be significantly affected by the project • Likely significant environmental effects resulting from the project • Forecasting methods used by the applicant to assess the potential effects • Proposed mitigation measures to prevent, reduce and offset potentially significant adverse effects • Main alternatives considered by the applicant and rationale for selected action A proposed project for which an ES is prepared may not proceed until the ES is reviewed and approved by the cognizant government authority responsible for project authorization.

B. Marine Current Turbines Ltd. – SeaGen and SeaFlow Projects (United Kingdom)

Marine Current Turbines Ltd. (MCT), a U.K.-based private firm, has developed and deployed the world's first large-scale commercial tidal stream generator, "SeaGen." A 1.2 MW, double-rotor turbine, SeaGen was installed in Strangford Narrows between Strangford and Portaferry in Northern Ireland in April 2008. The prototype for SeaGen, "SeaFlow", was installed off the coast of Lynmouth, North Devon, England as a pilot-scale project in May 2003. SeaFlow was a single-rotor turbine which generated 300 kW, but was not connected to the grid. SeaFlow was the world's first offshore tidal generator, and remained the world's largest until SeaGen was installed.[30]

In deploying both SeaFlow and SeaGen, MCT commissioned comprehensive reviews of the potential environmental impacts of both systems from independent environmental consultants. Pursuant to applicable licensing requirements within the United Kingdom, MCT commissioned an environmental consulting firm, Casella Stanger Ltd., to prepare an Environmental Statement in November 2001 for the SeaFlow project, evaluating the possible effects of system operation on waves, water flows, seabed, sediment, water quality, marine habitat, fish and cetaceans, sea birds and mammals, fisheries, navigation, and noise.[31] Casella

[30] Brittany Sauser, Technology Review, "Tidal Power Comes to Market: A large-scale tidal-power unit has started up in Northern Ireland" (July 29, 2008), http://www.technologyreview.com/Energy/21142/.

[31] Stewart Lowther, Casella Stanger, "Marine Current Turbines Ltd.: The SeaFlow Project, Off Foreland Point, North Devon," Environmental Statement, Non-Technical Summary (Nov. 2001).

Stanger's Environmental Statement also considered visual impact and landscape. The Environmental Statement determined that, on balance, the environmental impacts of the SeaFlow proposals are considered to be minor.[32] Specifically, the Environmental Statement concluded that the impact of the structure on water flows, the marine sediment transport system, water quality, diving birds, seabed organisms, fish and cetaceans, and other marine mammals was either minor or wholly insignificant. Moreover, the Environmental Statement concluded that the structure's potential impacts on fisheries were resolvable, and that there would be no significant navigation or noise impacts.[33]

Subsequent monitoring of the SeaFlow project indicated that there was a low likelihood of collisions between the SeaFlow's rotor and fish and sea mammals. Further, monitoring indicated that the system's rotor did not significantly impact downstream water flow.[34] Largely because of SeaFlow's success, the UK government now includes "tidal stream energy" as a defined area of interest for renewable energy development, and the offshore marine licensing regime specifically provides licenses for tidal stream turbines.[35]

In 2005, the Environment division of Royal Haskoning Ltd., an independent consultancy firm, prepared an Environmental Statement in support of regulatory authorization for the subsequent SeaGen project. Royal Haskoning's Environmental Statement concluded that the environmental impacts arising from construction, operation, and decommissioning of the SeaGen system were likely to be insignificant.[36] To date, this conclusion has proven sound. As part of SeaGen's operating conditions, MCT maintains a structured environmental monitoring program in conjunction with independent consultant Sea Mammal Research Unit Ltd., Queens University Belfast, and Royal Haskoning, to determine any immediate or emerging adverse impacts on the habitats, species, and physical environment of Strangford Lough.[37] The most recent monitoring report, prepared by Royal Haskoning in April 2010, indicates that SeaGen continues to operate without having a significant impact on the surrounding marine environment:

- There is no indication that marine mammals, fish, or sea birds in the area interact with the SeaGen installation. No incidental takings of such species have been observed.

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[32] *Id.* at 7.
[33] *Id*. at 6-8.
[34] Jeremy Thank, IT Power, "Development, Installation, and Testing of a Large-Scale Tidal Current Turbine" (2005), http://library.coastweb.info/320/1/file18130.pdf%3Fpubpdfdload%3D05%252F1698.
[35] European Commission, Directorate General for Research - Energy, Doc. EUR21616, SeaFlow Pilot Project for the Exploitation of Marine Currents (2005), http://ec.europa.eu/research/energy/pdf/seaflow_en.pdf.
[36] Alistair Davison & Tom Mallows, Royal Haskoning, Strangford Lough Marine Current Turbine Environmental Statement (June 2005), at v.
[37] Royal Haskoning, Press Release, "Royal Haskoning helping safe interaction between marine current turbine and local wildlife" (Sept. 30, 2010), http://www.royalhaskoning.com/en-GB/NewsAndDocumentation/Pages/RoyalHaskoninghelpingsafeinteractionbetweenmarinecurrentturbineandlocalwildlife.aspx.

- The unit does not appear to fragment the aquatic environment or significantly alter animal behaviors.
- Benthic monitoring indicates that SeaGen does not significantly affect the benthic community by its presence or operation.
- SeaGen's effect on the Lough's hydrodynamic regime has proven minimal, with only minor scour of an area less than 1 meter from the base of the seabed observed.[38]

References:

- Please see Appendix B-2 to review Environmental Statement, Non-Technical Summary, for SeaFlow project.
- Strangford Lough Marine Current Turbine (SeaGen) Environmental Statement, available at http://www.seageneration.co.uk/downloads.asp (To Access the Full Environmental Statement, Register in "Downloads Area").
- SeaGen Environmental Monitoring Programme: Biannual Update (April 2010), available at http://www.seageneration.co.uk/downloads/SeaGen%20biannual%20report%20April%202010.PDF

C. Blue Energy Canada Inc. – Vertical Axis Hydro Turbine (Canada)

Blue Energy, a Canadian renewable energy firm, is the developer of the Davis Hydro Turbine, a vertical-axis hydro turbine with a minimum generating capacity of 125 kW. This turbine can be deployed as an individual, stand-alone unit or as an ocean class "tidal bridge."[39] Blue Energy's turbine design is based on long-existing technology developed and tested by its predecessor, Nova Energy Ltd. In the 1980s, Nova Energy successfully built and field-tested two experimental 20 kW test units and three prototype Davis Hydro Turbines through a $1.3 million, 10-year collaborative R&D program with the National Research Council of Canada. As part of field testing in the St. Lawrence Seaway, Nova Energy engaged in environmental monitoring to measure the environmental and ecological impact of the slow-moving turbine units. At that time, Nova Energy recorded zero fish kill. Fish passed through the structure without any impact. Additionally, the turbines did not impact natural oceanic silt transport.[40]

Blue Energy's Davis Hydro Turbine is designed to have minimal environmental impact. Since the rotors and housings densely fill their section of water, marine mammals that use echo-location for navigation perceive the units as solid barriers and avoid them. Fish sense the pressure bubble in front of the rotors as an

[38] Gemma Bedford & Frank Fortune, Royal Haskoning, SeaGen Environmental Monitoring Programme: Biannual Update, Version 1, Environmental Monitoring July 2009 – Jan. 2010 (April 2010).
[39] Blue Energy Canada Inc., Blue Energy Technology, http://www.bluenergy.com/Technology.htm .
[40] Pelc & Fujita, *supra* note 11, at 477.

obstruction and tend to avoid it. Smaller fish can pass through unharmed. In order to protect schooling fish during spawning runs, the entire system can be shut down within two revolutions through its auto-braking system. The auto-braking system is controlled by sonar sensors capable of detecting marine life that wander too close.[41]

D. Wave Dragon – Overtopping Wave Energy Conversion Technology (Denmark / United Kingdom)

Developed through joint funding by the European Union, Welsh Development Agency, Danish Energy Authority, and Danish utilities sector, the Wave Dragon is a floating, slack-moored "overtopping" wave energy conversion device. The Wave Dragon generates power via the consistent collection and flow of waves over the top of the device into a central reservoir, which is connected to a turbine out-take system.[42] Collected water exits the turbines through a differential in water pressure and spins the turbines as it flows past, generating electricity. Electricity is transmitted back to land via an underwater transmission cable.[43]

In April 2003, Wave Dragon's initial developer, Wave Dragon ApS of Denmark, deployed a 237-ton, 1:4.5 scale prototype device in Nissum Bredning, an inland sea connected to the Danish North Sea. The prototype was tested continuously until January 2005 to assess proof of concept and technical feasibility, with continual monitoring by researchers from Aalborg University in Denmark.[44] Due to the temporary nature of testing and relatively small size of the prototype unit, Danish authorities did not require execution of a pre-project Environmental Impact Assessment. However, throughout the testing process, operational monitoring observed no significant environmental impacts.[45]

In the next phase of development Wave Dragon Ltd., a British affiliate of the Danish company, is seeking to deploy a 4-7 MW device off the Pembrokeshire coast in Wales for pre-commercial demonstration. Pursuant to British regulatory authorization requirements, Wave Dragon commissioned PMSS Ltd., an international

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[41] Blue Energy Canada Inc., Grant Application AEA10-015, Renewable Energy Fund Round 3, Submitted to Alaska Energy Authority for Angoon Commercial Demonstration Tidal Power Project Renewable Energy Fund (Oct. 7, 2009), ftp://200-10-178-69.static.gci.net/RENEWABLE%20ENERGY%20FUND/RFA%20November%202009%20Round%20III/520_The%20Angoon%20Commercial%20Demonstration%20Tidal%20Power_Blue%20Energy%20Canada,%20Inc.pdf/AEA%20RFA%20Submission%20from%20Blue%20Energy.doc ; *see also* Blue Energy Canada Inc., Ecological Advantages, http://www.bluenergy.com/Ecological.htm .

[42] Wave Dragon Wales Ltd, Wave Dragon Pre-Commercial Wave Energy Device (2007) at 5.

[43] *Id.* at 8; *See also* Wave Dragon, Specifications, http://www.wavedragon.net/index.php?option=com_content&task=view&id=7&Itemid=7 .

[44] Wave Dragon, Prototype, http://www.wavedragon.net/index.php?option=com_content&task=view&id=12&Itemid=14 .

[45] Telephone interview with Dr. Hans Christian Sørensen, Chairman of the Board, Wave Dragon (Nov. 8, 2010).

consulting firm, to prepare an Environmental Statement.[46] Based on data collected in the prototype stage and operational modeling, PMSS's Environmental Statement concluded that the Wave Dragon is, on balance, an environmentally benign form of power production. In particular, the Statement noted that:

- The potential impacts upon the existing sediment and water quality are minor.[47]
- The potential impacts for currents, scour effects, sediment transport, and sediment suspension are insignificant.[48]
- The potential impacts to the onshore environment are insignificant.[49]
- The potential impacts of installation activities, other than work on the cable route, are minor to moderate.[50]
- The potential impact on seabed communities arising from operations is minor to moderate.[51]
- Micro-siting of the device and benthic surveys could fully minimize the potential impact of the installation on endangered or threatened species found in bedrock reef habitats in the area.[52]
- The potential impacts on commercially important local species such as crabs, lobsters and crawfish are minor.[53]
- The potential noise impacts on the local fish populations are minor.[54]
- The risk of fish passing through the Wave Dragon's collection reservoir is low, making the potential impact of encounters minor.[55]
- The potential impacts of electromagnetic field radiation are minor to moderate.[56]
- Apart from noise generated during the construction phase, the potential impacts of operation to marine mammals are minor.[57]

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[46] PMSS Ltd., Wave Dragon Pre-Commercial Wave Energy Device, Environmental Statement, Non-Technical Summary, Vol. I (April 2007).
[47] *Id.* at 8.
[48] *Id.*
[49] *Id.* at 8-9.
[50] *Id.* at 10.
[51] *Id.*
[52] *Id.*
[53] *Id.*
[54] *Id.* at 10, 14.
[55] *Id.* at 10-11.
[56] *Id.* at 11.
[57] *Id.*

- The potential impacts to rocky reef, intertidal, and beach areas as a result of cable landfall are negligible to moderate.[58]
- The potential impacts to bird species are minor.[59]

Wave Dragon submitted PMSS's Environmental Statement to UK regulatory authorities in April 2007 for review and consent. At this time, the Environmental Statement remains under review.

References:

- Environmental Statement, Non-Technical Summary, available at http://waveenergy.dk/files/WDNTS.pdf?PHPSESSID=03be3fac970efe4b40fd724696c5ba8e

E. South West Regional Development Agency - Wave Hub (United Kingdom)

Developed by the South West Regional Development Agency (RDA) in the UK, Wave Hub operates as a "power splitter" under the sea.

Wave Hub's core purpose is to serve as a central connector for various wave and sea power generation devices, permitting centralized transmission of electricity to an on-shore station for delivery to the power grid. Additionally, by allowing technology developers to connect prototypical devices to its power supply, Wave Hub serves as a key enabling technology which may push prototypical wave power devices towards commercial deployment. Its core components include: (1) four off-shore power converter units attached to a central hub capable of transmitting energy sent to the hub to the onshore plant, (2) an underwater cable connecting the offshore hub to an onshore plant, and (3) an onshore substation that receives power from the hub and connects it to the grid for national deployment.[60]

Pursuant to British regulatory authorization requirements, the South West RDA commissioned environmental consultant Halcrow Group Ltd. to prepare an Environmental Statement for project authorization by regulatory authorities. On balance, Halcrow Group's Environmental Statement concluded that Wave Hub's deployment and operation will present minimal environmental impacts and that most impacts will be temporary and self-correcting, stemming largely from installation of the system. Operational impacts are expected to few and all of minor to moderate significance, involving visual aesthetics, limitations on fishing activities, and ship navigation. The most severe environmental consequence of operation is likely to be the electromagnetic field generated from the cable on species sensitive to electromagnetism, such as sharks. However, Halcrow

[58] *Id.* at 12.
[59] *Id.*
[60] Wave Hub, Information for Developers, Technical Information, http://www.wavehub.co.uk/information_for_developers/technical_information.aspx .

Group's Environmental Statement concludes that this impact will likely be minor. In light of affirmative mitigation measures taken before and during deployment, the Environmental Statement's overall conclusion is that deployment and operation of Wave Hub will not result in any significant environmental impacts.[61]

On the basis of Halcrow Group's Environmental Statement for the Wave Hub project, the relevant regulatory authorities within the UK Government granted South West RDA authorization to deploy of the Wave Hub off the Northern Cornish Coast of England. The Wave Hub was deployed 10 miles off the Northern Cornish coast in September 2010.[62]

References:

- Wave Hub Environmental Statement available at http://www.wavehub.co.uk/information_for_developers/environmental_impacts.aspx
- Government authorizations for Wave Hub available at http://www.wavehub.co.uk/information_for_developers/consenting_and_safety_zones.aspx

F. Nova Scotia Power – Open-Center Tidal Turbine Demonstration (Nova Scotia, Canada)

In November 2009, Nova Scotia Power Inc. (NSP) of Canada successfully launched a 1 MW, commercial-scale tidal energy demonstration project in the Bay of Fundy, Nova Scotia, Canada, as part of a regional Bay of Fundy tidal demonstration initiative established and managed by the Fundy Ocean Research Centre for Energy (FORCE), a not-for-profit, government funded company. Developed by OpenHydro Group Ltd. of Ireland, the 10 meter, 400-ton turbine was deployed in the high-current Minas Passage near Parrsboro, Nova Scotia.[63]

The OpenHydro turbine consists of a horizontal axis rotor with a single moving part and power take-off through a direct-drive, permanent magnet generator. It is principally comprised of the rotor and the stator; there is no requirement for a gearbox. The OpenHydro turbine rests on a gravity-based foundation, with no anchor placements, pilings, or surface-piercing structures deployed as part of the installation. Both the turbine and its foundation are specifically designed to be fully removable for scheduled maintenance or other needs. Power generated by the turbine is transmitted directly to the power grid via seabed cable.[64]

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[61] *See* Halcrow Group Ltd., Wave Hub, Environmental Statement (June 2006), at 254-264.

[62] South West Regional Development Agency, Press Release, "Wave Hub Successfully Deployed on Ocean Floor" (Sept. 6, 2010), http://www.southwestrda.org.uk/news_and_events/2010/september/wave_hub_successfully_deployed.aspx.

[63] OpenHydro, Press Release, "OpenHydro Successfully Deploys 1MW Commercial Tidal Turbine in the Bay of Fundy" (Nov. 17, 2009), http://www.openhydro.com/news/OpenHydroPR-171109.pdf .

[64] AECOM Canada Ltd., Environmental Assessment Registration Document – Fundy Tidal Energy Demonstration Project, Vol. I – Environmental Assessment (June 2009), at 13-14.

As part of the FORCE tidal demonstration initiative, the NSP project was subject to environmental review under an Environmental Assessment prepared by AECOM Canada Ltd. and approved by the Nova Scotia Department of Environment.[65] AECOM's Environmental Assessment considered the potential impact of deploying the OpenHydro turbine, in conjunction with two other demonstration turbines, on marine benthos, marine fish, marine mammals, marine birds, marine and terrestrial species at risk, terrestrial wildlife and wildlife habitat, water quality, intertidal environment, recreational and commercial fishing, archaeological and heritage resources, and tourism and recreation.[66] On balance, AECOM's Environmental Assessment determined that, with the implementation of proposed mitigation measures, the tidal demonstration initiative would not result in any significant environmental impacts.[67]

To ensure that no significant impacts will arise, the project is accompanied by a comprehensive monitoring program managed by FORCE, in conjunction with Nova Scotia Power, the Nova Scotia Department of the Environment, Canadian Federal Department of Fisheries and Oceans, Offshore Energy Environmental Research Association, and a variety of independent contractors and research institutions. Throughout the course of the project, information concerning the turbine's effect on the marine environment will be collected for continual assessment, with adaptive management measures implemented as necessary.[68]

Of key import, the OpenHydro open-center turbine was selected for deployment in the FORCE tidal demonstration project in part due to its successful environmental record. Having been previously deployed at the European Marine Energy Center in Orkney, Scotland without significant environmental impacts, the OpenHydro turbine operates as an advanced tidal energy technology with minimal environmental effects due to key design features.

- The turbine's rotor blade tips are retained within the outer housing and are thus not exposed. Accordingly, the turbine's large open center provides a safe passage for marine life.
- The rotor operates at a low rotational speed.
- The turbine's clean hydrodynamic lines ensure that fish will not become entangled therein.
- Tests have confirmed that the unit produces very low levels of mechanical noise.
- The turbine operates without greases and other lubricating fluids, eliminating the risk of effluent discharges into the surrounding environment.

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[65] *Id*.; *see also* Letter of Sterling Belliveau, Minister, Nova Scotia Department of Environment, to John Woods, FORCE Member, approving Proposed Fundy Tidal Energy Demonstration Project (Sept. 15, 2009).
[66] *Id*. at iii.
[67] *Id*. at 213-14.
[68] *Id*. at 11.

- The rotor can be stopped quickly and remotely in the event of an emergency.[69]

Due to mechanical error, the NSP project was temporarily halted in June 2010. Between November 2009 and June 2010, no significant environmental impacts were observed as a result of the turbine's operation. Upon completion of repairs to the turbine, demonstration activities will resume.[70]

References:

- Environmental Assessment and Nova Scotia Department of Environment consent letter available at http://www.gov.ns.ca/nse/ea/minas.passage.tidal.demonstration.asp

G. Voith Hydro Wavegen Ltd. – LIMPET and Siadar Oscillating Water Columns (United Kingdom)

With nearly 20 years of operational experience, Voith Hydro Wavegen Ltd. (Wavegen) of the United Kingdom has pioneered development of environmentally benign land-based and nearshore Oscillating Water Column (OWC) technologies. Its first OWC systems, the Land Installed Marine Power Energy Transmitter (LIMPET) was constructed in man-made gullies along the shoreline of the Scottish island of Islay, facing the open Atlantic Ocean. Between 1991 and 1999, Wavegen and Queens University Belfast tested a 75 kW pilot LIMPET unit on the island to obtain information on the technical feasibility and the environmental impacts of the LIMPET system. Since 2000, a commercial-scale LIMPET with a generating capacity of 500 kW has been deployed on the island, making the LIMPET the world's first commercial wave power device connected to a national grid.[71]

The Islay LIMPET uses an oscillating water column to drive air in and out of a pressure chamber through a specially designed air turbine. The water collection chamber of the LIMPET is an inclined concrete tube with its opening below the water level. As external wave action causes the water level in the chamber to oscillate, the variation in water level alternately compresses and decompresses the trapped air above, causing air to flow backwards and forwards through a pair of contra-rotating turbines, driving a generator.[72] Through nearly 20 years of operation, LIMPET has demonstrated that shoreline wave energy devices are environmentally benign

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[69] *Id.* at 12-15; *see also* OpenHydro, Technology: Environmental Impact, http://www.openhydro.com/techImpact.html; Testimony of Craig W. Collar, Senior Manager, Snohomish Public Utility District No. 1, before the House Committee on Energy and Technology, Subcommittee on Energy and Environment, *Marine and Hydrokinetic Energy Technology: Finding the Path to Commercialization* (Dec. 3 2009), http://gop.science.house.gov/Media/hearings/ energy09/ dec3/Collar.pdf .

[70] Tidal Today, Bi-Weekly Intelligence Brief (10 June – 24 June), http://social.tidaltoday.com/intelligence-brief/bi-weekly-intelligence-brief-10-june-24-june .

[71] *See generally* Queen's University Belfast, Islay LIMPET Wave Power Plant (2002), www.wavegen.co.uk/pdf/LIMPET%20publishable%20report.pdf; Voith Hydro Wavegen Ltd., Islay, http://www.wavegen.co.uk/what_we_offer_limpet_islay.htm .

[72] *Id*.

systems for aquatic power generation. By virtue of its placement, the LIMPET generating plant has a low visual intrusion and minimal impact on local flora and fauna. This minimal disturbance is a result of the structure replicating the existing natural environment in its design.[73]

In January 2009, the Scottish government approved development of a nearshore OWC, to be installed by Wavegen on behalf of British utility RWE npower Renewables at Siadar, Isle of Lewis, in the Western Scottish Isles. The Siadar Wave Energy Power (SWEP) will consist of a concrete breakwater type structure with energy conversion devices embedded within, located approximately 350m off the western shore of Siadar. Utilizing a similar OWC system to that of the LIMPET, the breakwater structure will be capable of generating up to 4MW of electricity for transmission to the national electricity grid via electrical cable.[74] The SWEP is expected to be operational by early 2011.

In granting consent for the SWEP development, the Scottish Ministers reviewed and largely approved the findings of an Environmental Statement prepared by environmental consulting firm Xodus AURORA on behalf of RWE npower Renewables.[75] Xodus AURORA's Environmental Statement provided comprehensive assessment of the potential impacts of project construction, operation, and decommissioning on terrestrial geology, hydrology, hydrogeology, terrestrial habitats and ecology, marine habitats and ecology, cultural heritage, coastal processes, and visual aesthetics. The Environmental Statement also considered the potential impacts of the project on onshore and underwater noise generation, electromagnetic field generation, and transport/route access. Specifically, the Environmental Statement found the following:

- Adherence to requirements in a proposed Environmental Management Plan would ensure that the residual effects on terrestrial geology, hydrology, and hydrogeology are temporary and of minor to insignificant gravity.[76]
- Development of the SWEP would have minor to insignificant impacts on terrestrial habitats and ecology, including designated sites, habitats and flora, birds, otters, migratory salmonids and red deer.[77]
- The overall effect of the project on the marine ecology, including marine habitats and species in the area, would be primarily insignificant in nature, rising to minor in one instance.[78]

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[73] *Id*. at 8.
[74] *See* Consent Letter of Jamie Hume, Deputy Director – Renewable Energy, Scottish Government, to Simon Robinson, nPower Renewables Ltd. (Jan. 22, 2009), http://www.scotland.gov.uk/Resource/Doc/917/0076500.pdf.
[75] Consent Letter, *supra* note 67.
[76] Xodus AURORA, Siadar Wave Energy Project Environmental Statement (2008), at 101.
[77] *Id*. at 123-24.
[78] *Id*. at 144.

- Proposed mitigation measures would render the effect of the SWEP on the onshore cultural minor. Moreover, construction of the breakwater could have a positive impact by reducing the energy of waves presently impacting the headland at the north end of the bay and provide protection to the presently eroding coastline which contains cultural artifacts.[79]
- Construction of breakwater structure would likely reduce coastal erosion, but would otherwise have minimal impact on coastal processes.[80]
- If reasonable steps are taken to reduce noise levels during the construction phase, the onshore noise impact would be, at worst, moderate. Operational on-shore noise would be minor to insignificant, and decommissioning noise would be minimal.[81]
- On clear days, the proposed SWEP development would have a moderate effect on the landscape/seascape and a moderate effect on the visual amenity of the study area. However, such impacts could be minimized through a variety of mitigation measures and careful consideration of scale, design and location and will not significantly affect designated sites or areas.[82]
- The proposed SWEP development would have an insignificant effect on the marine traffic in the area, primarily due to the low levels of baseline traffic utilizing the area and the shallow water location of the primary structures. In addition, despite increased road traffic during the construction period, the overall impact of heavy goods vehicles would be moderate to insignificant with implementation of mitigation measures. During the operational period, road traffic impact would be insignificant. During the decommissioning phase, road traffic impact would be minor, a level which will depend on the extent of the decommissioning works.[83]
- Deployment of the SWEP would produce net socioeconomic benefits, including operational and tourism benefits, increased full time employment, and increased housing incomes in the area.[84]
- Underwater noise impacts on marine species would be moderate during the short construction process, but minor during the operation phase.[85]
- The effects of electromagnetism on species in the area would be insignificant for all scenarios proposed. This is primarily due to the shallow bay not being particularly important for species which have any level of sensitivity and proposed mitigation measures.[86]

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[79] *Id*. at 165.
[80] *Id.* at 189.
[81] *Id*. at 217.
[82] *Id.* at 259.
[83] *Id.* at 281.
[84] *Id*. at 303.
[85] *Id*. at 327.
[86] *Id.* at 328.

References:

- Technical Report on Islay LIMPET Wave Power Plant available at www.wavegen.co.uk/pdf/LIMPET%20publishable%20report.pdf
- Please see Appendix B-3 to review Environmental Statement for Siadar Wave Energy Project.
- Government Consent for Siadar Wave Energy Project available at http://www.scotland.gov.uk/Resource/Doc/917/0076500.pdf

H. Pelamis Wave Power Ltd. – Pelamis Wave Energy Converter (United Kingdom)

Developed by Pelamis Wave Power Ltd., the Pelamis Wave Energy Converter is a long, semi-submerged, cylindrical, multi-jointed structure which harvests renewable energy from the ocean. Akin to a "sea snake," the Pelamis generates power by using the machine's bobbing motion at the joints to move hydraulic pumps connected to electricity-producing generators. [87]

In 2004, a prototype Pelamis unit was successfully tested at the European Marine Energy Center in Orkney, Scotland.[88] No significant environmental impacts were reported as a result of this demonstration project.[89]

In 2008, Pelamis teamed up with Babcock & Brown, an Australian infrastructure company, to finance the development of the Aguçadoura Wave Farm off the coast of northern Portugal. Three 750 kW Pelamis units were deployed, creating the world's first multi-unit commercial wave farm. Power continues to be successfully exported from the wave farm to the local power grid. No significant environmental impacts were reported as a result of this project.[90]

Currently, Pelamis Wave Power is in the process of developing additional wave farm projects with various partners at several locations: a 50MW site off the coast of Sutherland Scotland; a 20MW site off the coast of Shetland, Scotland; two 50MW sites in the Pentland Firth off the coast of Orkney; and up to 20 MW off the cost of Great Bernera, Western Isles, Scotland.

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[87] *See* Pelamis Wave Power, Pelamis WEC, http://www.pelamiswave.com/our-technology/pelamis-wec

[88] *See* Pelamis Wave Power, Press Release "Pelamis Wave Power celebrates Outcome of The Crown Estate's Pentland Firth and Orkney Waters Leasing Round" (March 16, 2010), http://www.pelamiswave.com/assets/media/pwp_tce_press_release_160310.pdf; BBC News Online, "Policies Trigger 'Wave' of Energy"(July 13, 2006), http://news.bbc.co.uk/2/hi/uk_news/scotland/north_east/5173844.stm .

[89] Telephone interview with Ms. Laura Carse, Project Development Manager, Pelamis Wave Power (Nov. 1, 2010).

[90] *Id.*

In its various deployments, Pelamis Wave Power has conducted numerous environmental studies concerning the environmental impacts of the Pelamis Wave Energy Converter. These studies have demonstrated that the Pelamis device is an environmentally benign form of wave power generation that does not cause significant environmental impacts on fish, birds, other marine animals, or the marine environment. For example, an Environmental Report prepared for ScottishPower Renewables and Pelamis for deployment of the Pelamis P2 device at the European Marine Energy Centre at Orkney concluded the following:

- Fish are known to congregate around objects rising from the seabed. Pelamis machines and the associated mooring equipment will most likely attract fish shoals and, through providing shelter from fishing activities, the populations of indigenous fish species could increase. This increase will have no adverse affect upon the fish themselves.[91]
- The Pelamis will not cause any significant negative impact on birds. The machines may have some positive impacts. An increase in fish numbers may provide better feeding for local diving birds. In addition, the structure of the machines will act as resting rafts for local and transient bird groups. Pelamis machines do not pose great structural threats to flying birds due to their low profile. Moreover, they present only very local obstructions to diving birds. Birds standing on, or floating close to, the structures are at minimal risk to the movement of the machine since rotational movements between sections are slow, with short excursions.[92]
- The Pelamis does not cause any significant impacts to marine mammals. Though marine mammals may be required to navigate around Pelamis machine structures, associated moorings, and cables, the design and movement of the machinery, including the bend radius and tension of the cables, are such that entanglement with marine mammals is exceptionally unlikely.[93]
- The noise generated by the Pelamis has no significant impact on wildlife. Sounds emitted from the Pelamis are low at any particular time. The spinning of the motors and generators produce minimal noise, muted by air surrounding these components within the tubes. Machines will be located in one position for much of the time allowing sea life to become acclimated to their presence.[94]

References:

- Please see Appendix B-4 to review Environmental Report for ScottishPower Renewables project.

I. BAL Chile S.A. – Macroalgae Mariculture for Production of Biofuels (Chile)

[91] Environmental Report, Multiple Wave Energy Converter Project (2007), at 41.
[92] *Id*. at 42.
[93] *Id*. at 43.
[94] *Id*. at 49.

BAL Chile S.A., a subsidiary of Bio Architecture Laboratories Inc. (BAL) of the United States, established an aquafarm in Chile to develop macroalgae as a potential feedstock for the production of ethanol. Macroalgae is a low-cost, scalable, and renewable source of biomass energy that can be grown and farmed offshore. Macroalgae does not require land, fertilizer, or fresh water, and it improves the local ocean environment by removing inorganic nutrients from the water.

BAL acquired 20 hectares at one site, and subleased 30 hectares from Pesquera San José S.A. (Pesquera) at a different site. Pesquera was using the second site for growing mussels. Accordingly, BAL commissioned Plancton Andino Ltda., an environmental consultant specialized in aquacultural and marine activities, to prepare a *Declaración de Impacto Ambiental* (Environmental Impact Statement) assessing the potential environmental impacts of aquafarming macroalgae at the site.

Issued in September 2010, the *Declaración de Impacto Ambiental* made the following findings with respect to the current use of the site for mussels farming:

- The mussels have not significantly affected the composition or abundance of macrofauna in the project area. Specifically, the composition and abundance of macrofauna has remained stable.[95]
- No alterations in pH or redox potential have been observed, which shows there has not been a negative impact on the oxidation of organic matter in the sediment.[96]
- There was no difference in sediment grain size or in the percentage of organic matter in the project area.[97]
- The aquafarming did not cause any significant changes in the environmental condition of the project area.[98]

The *Declaración de Impacto Ambiental* also concluded the following with respect to the proposed macroalgae aquafarming:

- Macroalgae aquafarming presents no public health risk, due to the quantity and quality of effluents, emissions, or wastes.[99]
- Macroalgae aquafarming will not generate significant adverse effects on the quantity and quality of renewable natural resources, including land, water, and air. [100] Macroalgae aquafarming is not likely to

[95] *Id.* at 32.
[96] *Id.* at 32.
[97] *Id.* at 32.
[98] *Id.* at 6.
[99] *Id.* at 31.

emit a significant amount of gases into the atmosphere.[101] Further, the project site has specific characteristics that minimize the visual impact.[102]

- Macroalgae aquafarming is not likely to have a significant adverse effect on the marine physical environment. Macroalgae aquafarming will replace significant units of farmed mussels and abalone, organisms that more intensely use the environment.[103]
- Macroalgae aquafarming does not pose a risk for vulnerable or endangered species of marine flora and fauna. BAL will implement mitigation measures to protect mammals and birds.[104]
- Macroalgae aquafarming is not likely to have significant adverse effects on communities and services. Macroalgae aquafarming takes place exclusively underwater and does not involve facilities on land. There are no specially protected communities or groups in the area where the Macroalgae aquafarming will take place, nor are there religious ceremonies or other events specific to the culture and folklore that are affected by the macroalgae aquafarming.[105]
- Macroalgae aquafarming is not likely to have a significant adverse effect on areas with scenic or touristic value or on areas with historical significance. Specifically, the project will not create or present changes to monuments or sites with anthropological, archaeological, or historical value.[106]
- The project site is not located in any area that is latent or saturated by a pollutant.[107]
- The project site is not located next to protected resources or protected areas that are susceptible to negative effects from the presence and activity of macroalgae aquafarming.[108]
- Macroalgae farming does not include activities or buildings on land, and it will not obstruct access to camping areas and / or shelter for fishermen.[109]
- The only noise emissions identified as associated with macroalgae aquafarming would be from outboard engines on the boats working on the project. These were not predicted to rise to the level of a significant adverse noise or vibration effect.[110]

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[100] *Id.* at 32.
[101] *Id.* at 26.
[102] *Id.* at 36-37.
[103] *Id.* at 13.
[104] *Id.* at 14.
[105] *Id.* at 35-36.
[106] *Id.* at 37.
[107] *Id.* at 13.
[108] *Id.* at 36.
[109] *Id.* at 17.
[110] *Id.* at 26.

Finally, the *Declaración de Impacto Ambiental* made the following environmental observations:

- Macroalgae aquafarming has a lesser impact than local fish species (e.g., salmonids) and a substantially lesser impact than that of mussels farming.[111]
- The environmental impacts of macroalgae farming have been reported and verified, and no negative environmental effects have been reported for macroalgae in suspended farming.[112]
- Macroalgae systems have potentially positive environmental effects, including the reduction of coastal eutrophication processes.[113]
- Farming of the native algae *Macrocystis pyrifera* in the "Región de Los Lagos" does not present any danger, threat, or risk of introducing an exotic or genetically modified species.[114]
- Farming of the native algae *Macrocystis* does not require the use of chemicals or exogenous environmental products.[115]

References:

- *Declaración de Impacto Ambiental* (Environmental Impact Statement) available at https://www.e-seia.cl/archivos/DIA_Planchada_-_210103056__2_.pdf
- Please see Appendix B-5 to review English translation of the Declaración de Impacto Ambiental.

J. Statkraft SF – Pressure-Retarded Osmotic Power Plant (Norway)

In November 2009, Statkraft SF of Norway opened the world's first osmotic power (PRO) plant in Tofte, Norway. Integrated into a converted paper mill alongside a fjord 60 kilometers from Oslo, the Tofte plant employs pressure-retarded osmotic (PRO) technologies capable of generating 10 kW of electricity. By 2015, Statkraft seeks to deploy a commercial PRO power plant with a generating capacity of 25 MW, the equivalent power output of a small wind farm.

Statkraft's Tofte plant reflects the company's engagement in the development of osmotic power technology since 1997 and builds upon 30 years of general research and experimentation with osmotic pressure in power generation. The plant operates by pumping seawater into a reservoir that is separated from a distinct

[111] *Id.* at 10.
[112] *Id.* at 10.
[113] *Id.* at 10.
[114] *Id.* at 10.
[115] *Id.* at 10.

reservoir containing a freshwater solution by a semi-permeable polyimide membrane. As a result of the osmotic pressure difference between the two solutions, freshwater diffuses through the membrane into the seawater reservoir, thereby diluting the seawater and increasing its volume. Pressure compensation in the chamber spins a turbine to generate electricity.

Beginning in 2001, Statkraft commenced environmental optimization and environmental impact studies for the Tofte power plant. Prior to constructing the plant, the company issued an environmental statement summarizing the potential environmental impacts of operating a PRO system at the Tofte site. The statement concluded that no significant environmental impacts would arise as a result of plant operation. Further, while noting potential environmental impacts from the impoundment of water, the environmental statement concluded that such impacts could be substantially mitigated by (1) establishing environmental flow requirements for the river and plant and (2) implementing environmental engineering measures to control the effects of intake and discharge of brackish water. The environmental assessment concluded that the Tofte osmotic plant is likely to be, on balance, environmentally benign, extracting energy from the mixture of sea water and freshwater without significantly interfering with the environmental qualities of the site.

K. Dong Energy & Vattenfall Group - Horns Rev and Nysted Offshore Windfarms (Denmark)

In 1998, the Danish Government ordered the construction five demonstration offshore wind farms, but this number was reduced to two in 2002: Horns Rev and Nysted.[116] Horns Rev consists of 80 turbines totaling 160 MW, and is located 14-20 km off the Danish west coast in the North Sea.[117] Nysted consists of a total of 72 wind turbines with a total installed capacity of 165.5 MW, and is located approximately 10 km off the Danish coast.[118]

The building permits for Horns Rev and Nysted included an obligation to carry out comprehensive environmental monitoring programs, including detailed measurement of the environmental conditions before, during, and after the offshore wind farms were established.[119]

Between 1999 and 2001, comprehensive environmental studies were undertaken by several different expert entities and institutions as part of the requisite Environmental Impact Assessment for project authorization.[120]

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[116] Elsamprojekt A/S, Horns Rev Offshore Wind Farm, Environmental Impact Assessment (2000), at 4 [hereinafter "Horns Rev EIA"].

[117] Danish Energy Authority, *Danish Offshore Wind: Key Environmental Issues* (2006), at 11 [hereinafter "*Danish Offshore Wind*"].

[118] *Id.*

[119] *Id.* at 28.

[120] A complete listing of these reports can be found at http://www.hornsrev.dk/Engelsk/Miljoeforhold/uk-rapporter.htm

These studies were intended to provide a baseline for the Horns Rev and Nysted environmental monitoring programs, so environmental conditions prior to installation could be compared to conditions after installation.

In 2000, Danish engineering consultant Elsamprojekt A/S prepared a comprehensive Environmental Impact Assessment report[121] for the Horns Rev offshore wind farm, which found as follows:

- The construction work of the offshore wind farm and the cable connection to shore would have a minimal impact on the seabed, even in a worst-case scenario, compared to the shifting which takes place naturally.[122]
- The foundations would cover parts of the seabed but also provide a new habitat for fauna and flora. The Environmental Impact Assessment found the foundation's effects to be minimal.[123]
- The location of the foundations of the wind turbines would affect the currents in their immediate vicinity; however, the effects would be only of a very local nature. Model calculations showed that the total current velocity was reduced by 2% at the most before and after the establishment of the offshore wind farm.[124]
- During the establishment and maintenance of the offshore wind farm there would be some transport by ship and helicopter to the offshore wind farm site. However, the transport to the offshore wind farm constitutes only an insignificant part of the existing transport in the area.[125]
- The risk of accidental oil spillage was not a serious risk of the offshore wind farm.[126]
- Beforehand, the most serious biological concern of the offshore wind farm at Horns Rev was the possible impact on the large bird migrations along the West Coast of Jutland. Mapping of the distribution of the birds, however, showed that the distribution of birds in the area where the offshore wind farm was located was very limited. It was estimated that the largest risk for the birds would be to collide with turbine blades when chasing shoals of fish. Such collision was not expected to have any influence on the total population of local bird species.[127]
- There would only be a very limited reduction of the seabed area used by animals and plants.[128]

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[121] Horns Rev EIA, *supra* note 116, at 12.
[122] *Id.*
[123] *Id.* at 13.
[124] *Id.*
[125] *Id.*
[126] *Id.*
[127] *Id.*
[128] *Id.*

- Observations of the foundation of the established meteorological mast in the area have shown that new flora and fauna communities are established on the foundation. Observations further show that sand stirred up in storms practically scrubs the foundation clean of animals and plants. Thus fouling on the foundations was not expected to develop much.[129]
- The offshore wind farm was anticipated to influence the distribution of fish in the area in different ways. The amount of feed for the fish would not be influenced to any major extent. On the contrary, the offshore wind farm was foreseen to have beneficial effects in that fish – especially cod species – are attracted to physical structures on the seabed.[130]
- Submarine noise from the turbines and electromagnetic fields from the cables would – locally – have an influence on the distribution of fish, but seen as a whole, these impacts were considered likely negligible.[131]
- Even though the offshore wind farm may have a local, negative effect on the porpoise population, it was found that the offshore wind farm would in no way threaten the distribution of the species in the North Sea.[132]
- A number of visualizations were prepared to show the visual appearance of the offshore wind farm from various positions onshore. The curvature of the earth meant that the turbines would be impossible to see from a distance of 45 km. In practice, the visibility makes it difficult to the see the turbines at even shorter distances.[133]

Following installation, the Danish Forest and Nature Agency, the Danish Energy Agency, Vattenfall, and Dong Energy coordinated a comprehensive monitoring program[134] that examined the potential impacts of the Horns Rev and Nysted offshore wind farms, including:

- Benthic fauna and flora, with particular focus on the consequences of the introduction of a hard-bottom habitat (i.e., the turbine foundation and scour protection),[135]
- The distribution of fish around the wind turbines and the scour protection, and the effect of electromagnetic fields on fish,[136]

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[129] *Id.*
[130] *Id.* at 14.
[131] *Id.*
[132] *Id.*
[133] *Id.*
[134] *Danish Offshore Wind*, *supra* note 117, at 29.
[135] *Id.* at 10.
[136] *Id.*

- The numbers and distribution of feeding and resting birds, performed by aerial surveys, and of the food choice of scoters,[137]
- Migrating birds, including study of the risks of collision between birds and wind turbines,[138]
- The behavior of marine mammals – porpoises and seals – and their reaction to wind farms,[139]
- The impact of electromagnetic fields on fish,[140]
- Sociological and environmental-economic studies, and[141]
- Coastal morphology.[142]

The results of the monitoring studies were evaluated by the International Advisory Panel of Experts on Marine Ecology (IAPEME), which consisted of experts with unique competence within the individual branches of the entire monitoring program. These experts evaluated the progress of the program and made recommendations for future monitoring approximately once a year.[143]

The findings of these monitoring programs were published in a 2006 report entitled "Danish Offshore Wind: Key Environmental Issues." Among the findings were:

- Offshore wind farms, if placed right, can be engineered and operated without significant damage to the marine environment and vulnerable species.[144]
- Under the right conditions, even big wind farms pose low risks to birds, mammals and fish, even though there will be changes in the living conditions of some species by an increase in habitat heterogeneity.[145]
- Appropriate siting of offshore wind farms is an essential precondition for ensuring limited impact on nature and the environment, and careful spatial planning is necessary to avoid damaging cumulative impacts.[146]

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[137] *Id.*
[138] *Id.*
[139] *Id.*
[140] *Id.*
[141] *Id.*
[142] *Id.*
[143] *Id.*
[144] *Id.* at 8.
[145] *Id.*
[146] *Id.*

- The main effect from establishing the Horns Rev and Nysted wind farms was the introduction of hard bottom structures onto seabeds that almost exclusively consisted of sandy sediments. This has increased habitat heterogeneity and changed the benthic communities at the turbine sites from typical infauna communities to hard bottom communities. Abundance and biomass of the benthic communities increased at the position of the turbines compared to the native infauna communities. A consequence of the change in community structure was a local increase in biomass by 50 to 150 times, most of this as available food for fish and seabirds.[147]
- There were only negligible or no impacts detected from the changes in the hydrodynamic regimes on the native benthic communities, seabed sediment structure or established epifouling communities. Similarities in the establishment, succession and distribution of epifouling communities were found between Horns Rev and Nysted off shore wind farms. The differences in species composition were mainly attributable to differences in salinity between the two sites.[148]
- Data failed to provide significant statistical proof of the expectation of attracting fish to the artificial reef.[149]
- Data have documented some effects from the cable route on fish behavior indicating avoidance of the cable as well as attraction, depending on species. However, the observed phenomena were not significantly correlated with the assumed strength of the electromagnetic fields.[150]
- At Horns Rev, sandeel is one of the most abundant species of fish. Due to a known strong correlation between the distribution of sandeel and the composition of the sediments, the distribution of both sandeel and sediment composition was surveyed. The studies showed that the wind farm is unlikely to have a negative effect on the sandeel or any effect on sediment composition.[151]
- With respect to marine mammals, no general change in behavior at sea or on land could be linked to the construction or operation of the offshore wind farms. Seals also showed little response to the wind farms, except during the construction phase. The only effect detected on land was a reduction in the number of seals on land during pile driving operations at Nysted. Only a slight decrease in porpoise abundance was found at Horns Rev during construction, and no effect of operation of the wind farm was seen.[152]
- Radar, infrared video monitoring, and visual observations confirmed that most of the more numerous bird species showed avoidance responses to both wind farms, although responses were highly species

[147] *Id.* at 44.
[148] *Id.*
[149] *Id.* at 13.
[150] *Id.*
[151] *Id.*
[152] *Id.* at 14.

specific. Birds tended to avoid the vicinity of the turbines, and there was considerable movement along the periphery of both wind farms. Slightly extended migration distances are unlikely to have consequences for any species. Neither of the wind farms lies close to nesting areas to affect reproduction.[153]

- Post-construction studies showed almost complete absence of divers and scoters within the Horns Rev Offshore Wind Farm and significant reductions in long-tailed duck densities within the Nysted Offshore Wind Farm. Other species showed no significant change or occurred in too few numbers to permit statistical analysis. Although such bird displacement represents effective habitat loss, it is important to assess the loss in terms of the proportion of potential habitat affected relative to the areas which remain available outside the wind farms. For most of the species studied, that proportion is relatively small and therefore of little biological consequence.[154]
- Of 235,000 common eiders passing Nysted each autumn, predicted modeled collision rates were 0.02% (45 birds). The low figure was confirmed by the fact that no collisions were observed by infrared monitoring.[155]

References:

- Environmental Impact Assessment, Summary Report, for Horns Rev Offshore Wind Farm available at http://www.hornsrev.dk/Miljoeforhold/pdf/Resume_eng.pdf
- Danish Offshore Wind: Key Environmental Issues, available at http://193.88.185.141/Graphics/Publikationer/Havvindmoeller/danish_offshore_wind.pdf

L. Vattenfall Group – Kentish Flats Offshore Wind Farm (United Kingdom)

Operating since 2005, the Kentish Flats project is a utility-scale offshore wind farm owned and operated by Vattenfall, a Swedish-based utility company, and one of Europe's leading innovators in renewable energy technologies. The wind farm is located on a large, flat and shallow plateau, approximately 8.5 to 13 km off the northern coast of Kent, England.[156] Comprised of 30 efficient wind turbines capable of producing up to 3 MW of electricity each, the wind farm represents a combined generating capacity of up to 90 MW.[157] By British

[153] *Id.* at 14-15.
[154] *Id.* at 15.
[155] *Id.*
[156] Global Renewable Energy Partners, Kentish Flats Offshore Windfarm, Environmental Statement, Non-Technical Summary (2002), at 1.
[157] *Id.* at 2.

standards, the offshore wind farm has set a dual record: (1) the 30 turbine project is, to date, the largest wind farm installed in the UK, and (2) it hosts the largest wind turbines deployed in the UK.[158]

Prior to commissioning, the preceding owner of the development, Elsam, commissioned an independent consulting firm, Emu Ltd., to prepare an Environmental Statement in support of regulatory authorization for the project. Emu's Environmental Statement concluded that the Kentish Flats wind farm would not have a significant impact on the physical or human environment.[159] Further, the Statement found that operation, construction and decommissioning of the Kentish Flats wind farm would have no significant impacts on surrounding biological communities, marine mammals, fish and shellfish species, birds and conservation sites.[160] Among the Statement's findings are:

- Impacts on the animals living on the seabed as a result of the construction process are of low significance, due primarily to the small area affected by both turbine installation and cabling.[161]
- There will be no impact on rare species or habitats.[162]
- Impacts on ecology around the onshore construction sites are not expected to be significant because of the developed or disturbed nature of the sites or the low quality habitats that exist around these areas.[163]
- Impact on marine mammals will not occur during any phase of the Kentish Flats scheme, as these species are not commonly recorded in the region. In the cases where seals are seen, potential effects will be minimal, as seals are not considered sensitive to the project.[164]
- Impacts on fish and shellfish species are not expected to be significant.[165]
- The loss of seabed habitat is not considered significant and does not generally affect any spawning or juvenile nursery areas. The new structures could act to attract fish into the area and could even increase fish diversity and productivity in the longer term.[166]

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[158] *Id.* at 12.
[159] *Id*. at 6, 14.
[160] *Id.* at 6.
[161] *Id.* at 7.
[162] *Id.*
[163] *Id.*
[164] *Id.*
[165] *Id.*
[166] *Id.*

- Numerous sites around the Thames Estuary coastline are designated for their conservation interest. No direct impacts on any of these sites will occur as a result of construction operation or decommissioning, with one minor exception that has been mitigated.[167]
- Due to suitable mitigation measures, construction, operation and decommissioning activities would not have significant impacts on the environment.[168]
- The wind farm turbines will have only localized impacts on waves and tidal currents, and the associated transport of sediment in and around the structures.[169]
- Installation of cables will disturb surface sediment and the underlying clay and could result in scour along the length of the cable route. However, this impact will be of low significance since the sediment will be fully reinstated following installation.[170]
- There will be no significant impacts on water quality. Contaminant levels in the seabed sediments were tested and confirmed to be accepted, such that significant contamination as a result of sediment disturbance would not occur.[171]

In 2002, Elsam submitted the Environmental Statement prepared by Emu to UK licensing authorities. On the basis of the Environmental Statement's conclusions, the relevant regulatory authorities within the UK Government granted Elsam requisite consent to construct and operate the Kentish Flats offshore wind farm.

References:

- Environmental Statement, Non-Technical Summary, available at http://www.kentishflats.co.uk/multimedia/kentish_flats_nts.pdf
- Government Consent documentation available at http://data.offshorewind.co.uk/offshore_developers/?link=detail.php&id=Kentish_Flats (registration required to access documents)

M. Belwind NV - Belwind Offshore Wind Farm (Belgium)

Belwind NV, a Belgian company, is currently in the process of developing the Belwind Offshore Wind Farm on the Bligh Bank, 29 miles off the coast of Zeebrugge, Belgium, in the North Sea. The Belwind Offshore Wind Farm is being constructed in two phases. During Phase I, 55 wind turbines with a total capacity of 165 MW are

[167] *Id.*
[168] *Id.* at 8.
[169] *Id.* at 6.
[170] *Id.*
[171] *Id.*

being installed. Phase I commenced in August 2009, and the last turbine monopole was installed in February 2010. These turbines are scheduled to begin operation in the coming months. Phase II will involve the installation of another 55 turbines with a capacity of 165 MW.[172]

Prior to project implementation, Belwind commissioned Ecolas NV, a Belgian environmental consultancy firm, to perform a *Milieu Effecten Rapport* (roughly translated as "Environmental Impact Report") for the Belwind Offshore Wind Farm. Ecolas' provided comprehensive assessment of the potential impacts of project construction, operation, and decommissioning on soil, hydrodynamics, turbidity, coastal processes, water quality, air quality, climate, terrestrial habitats and ecology, marine habitats and ecology, visual aesthetics, and cultural heritage. The *Milieu Effecten Rapport* also considered the potential impacts of the project on onshore and underwater noise generation, electromagnetic field generation, commercial fishing, military operability, navigational safety, air traffic, and radar and ship communications. On balance, the report concluded that, in light of proposed mitigation measures, the Belwind Offshore Wind Farm will not have a significant adverse impact on the environment.

Specifically, the *Milieu Effecten Rapport* found as follows:

- With gravity foundations employed for the turbines, a considerable amount of surplus sand will be held in the concession area during the construction phase. However, the surplus sand could be stored in a location that ensures that the general morphodynamics of the area is changed as little as possible.[173]
- The impact of cable installation on the seabed is negligible. The risk of causing significant pollution of the soil is extremely low. If the cable route must be installed over the top of other cables and/or pipes, and the minimum installation depth cannot be realized, extra quarry stone could be installed to protect the soil.[174]
- Although there will be a disturbance of the natural sediment transport around the wind turbines during operation of the wind farm, the general natural transport processes on the Bligh Bank will not be significantly affected. Due to the proposed installation of an erosion protection system, the impact of each installation will be too small and the wind turbines will be too far apart to have a significant impact.[175]

[172] Belwind Offshore Energy, Facts and Figures, http://www.belwind.eu/files/belwind_facts_and_figures_en.pdf .
[173] *Id*. at V.
[174] *Id*. at V-VI.
[175] *Id*. at V.

- The construction of the foundation will, for each construction method and type of foundation, bring a local and temporary increase in turbidity. However, the impact will be negligible in comparison with the turbidity concentrations caused naturally by high winds.[176]
- Construction and operation of the wind farm will have no significant impact on the current, nor will the underground cables. Hydrodynamics will not be affected, irrespective of the type of foundation used.[177]
- The risk of water and soil pollution is extremely small. The potential impact of the release of organic pollutants from the top layer of sediment during construction is relatively minor. Dredging could cause a minor temporary increase in nutrients in the water column. However, no significant impact is expected with respect to temperature, dissolved oxygen or salinity. Further, the risk of an accidental discharge of pollutants with an immediate impact on the water quality is extremely small.[178]
- Construction and operation of the wind farm will not have a significant impact on air quality. While energy consumption related to obtaining and processing raw materials for component construction will result in some air emissions, operation of the wind farm will result in a net emissions decrease, including 1.04 to 1.19 % of the emission ceiling for Sulfur Dioxide (SO_2) and 0.55 to 0.62 % of the emission ceiling for Nitrogen Oxide (NOx). During operation of this wind farm, approximately 4 % of domestic greenhouse gas emissions will be prevented in comparison with traditional power stations. Emissions resulting from the shipping traffic will have very little impact on the local air quality near the Channel.[179]
- The dismantling phase of the project will have a positive influence on the energy consumption in the lifecycle of a wind turbine because approximately 80 % of the turbine materials can be used again. The extraction of new raw materials and related emissions will therefore be reduced.[180]
- As a consequence of the activities during the construction phase (pile-driving, ship movements, use of cranes, etc.), above-water and underwater noise levels will temporarily increase. However no significant effects are anticipated. During project operation, it is believed that background noise will mask the specific sounds of the turbine underwater, such that any marine fauna beyond a distance of 500 m will likely not be affected. The sound of the wind farm calculated in a moderately aggravating situation on the shoreline and in the nearest housing area will be lower than the measured background noise and therefore undetectable. As a result of the activities during the dismantling phase, the sound

[176] *Id*. at VII.
[177] *Id*.
[178] *Id*.
[179] *Id*. at IX-X.
[180] *Id*. at X.

levels will temporarily increase, above water as well as underwater. However no significant effects are anticipated.[181]

- During the construction phase, there will be a temporary loss of benthic habitat and a limited and temporary disturbance of the benthic fauna and fish. However, the influence of the mortality is not expected to have a major negative impact on the biomass or functioning of the local ecosystem. Most species sensitive to disturbance and sea mammals will probably leave the area, but return after the construction phase.[182]
- The potential closure of the project area to certain activities (such as trawler fishing) will have a positive effect on the benthos as well as fish stocks (refugium effect). Moreover, the introduction of a hard substrate in a sea area containing almost exclusively sandy sediments sea will lead to greater heterogeneity of the habitat, and the creation of a new community typical of hard substrates. It will also increase the abundance and the biomass of certain species at acceptable levels.[183]
- On balance, operation of the wind farm will not impact the majority of fauna species. The transmission of electricity via sub-sea cables will generate electric and magnetic fields, which could affect certain sensitive species (e.g., rays and sharks). However, given that significant impacts on such species within project areas is uncommon, and that transmission cables will be buried at a depth of 1 meter, the likely impact on sensitive species is small.[184]
- The installation of transmission cables may have a temporary, limited effect on sea mammals. During the exploitation phase, the electromagnetic fields generated by the cables will probably not have a discernable effect on the sea mammals. Sea mammals are mainly found in the water column, where the effect of magnetic radiation tends to be limited.[185]
- During the construction phase, a significant disturbance of the marine avifauna can occur as a result of the activities. Species sensitive to disturbances may consequently temporarily avoid the area; other species could possibly benefit from the activities by food becoming available temporarily (churning up of the seabed, increased shipping movements).[186]
- Operation of the wind farm may have a slightly negative impact on marine avifauna. The wind farm may cause hindrance to bird species that are sensitive to disturbance and collisions. The installation of the cables can result in a temporary disturbance of the avifauna by a change in food availability or altered turbidity in the water column. Disturbance of the sediment will cause increased turbidity which

[181] *Id*. at XI.
[182] *Id*. at XV.
[183] *Id*.
[184] *Id*. at XVII.
[185] *Id*. at XXII.
[186] *Id*. at XIX.

can affect fish with filter mechanisms and reduce the visibility for the birds feeding on fish. However, the disturbance effect on the most seabirds found in increased numbers in the Bligh Bank area during the migrating periods will probably be minimal. The impact on local bird movements will most likely be marginal.[187]

- During the construction of the wind farm, some disturbance for sea mammals can occur as a result of the activities being carried out, such as increasing turbidity of the water, underwater movements, noise and other activity on the seabed. Seismic surveys carried out prior to the construction phase of the wind farm can have a temporary, significant negative effect on sea mammals that find themselves in the close proximity to the sound source. However, temporary deterrent mechanisms can be used to mitigate and minimize the risk of damaging the hearing of the sea mammals. If mitigating measures are taken into account, the effect of seismic surveys and pile-driving on sea mammals is only slightly adverse.[188]
- Sea mammals could be temporarily affected by changes in food supply. The areas may become less attractive for the sea mammals and they may leave. Upon completion of construction, food sources are likely to recover. It is also expected that the sea mammals will return to the area as soon as the food sources have returned to normal.[189]
- The physical presence of the wind turbines (e.g. reflection in the sun, shadows of the rotating rotor blades) may have an impact on certain sea mammals and cause them to use the area less or abandon it completely. But sea mammals could also be attracted to the area: to use it as a resting place or as a defense against predators. The effect of the physical presence of the wind turbines on sea mammals is judged to be negligible. Over time the sea mammals could get used to them.[190]
- During the construction of the wind turbines, there will be a temporary visual disturbance of the landscape caused by the presence of wind farm components, such as foundations (the parts that protrude above the water), wind turbines and offshore transformer stations, and an increase in shipping movements. However, from shore, the wind farm will only be vaguely visible in exceptionally clear weather conditions. The visual impact of the project is therefore judged to be slightly negative.[191]
- The construction, operation and decommissioning of the wind farm will not have any direct or indirect effect on the cultural and landscape heritage along the coast.[192]

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[187] *Id.* at XIX, XVIII.
[188] *Id*. at XIX, XX.
[189] *Id*. at XX.
[190] *Id*. at XXI.
[191] *Id*. at XXII.
[192] *Id*. at XXIII.

- A positive effect is expected on traditional fishing in the vicinity. Moreover, the closure of small areas to trawler fishing could have a significant positive effect on the fishing in nearby areas (bigger catches).[193]
- In view of the position and distance of the installation in relation to neighboring countries, some limited border crossing effects can be expected concerning the Netherlands. However, these effects are minimal. Only a limited effect can be expected with respect to noise, sea view and safety.[194]
- Installation of the off-shore wind farm on the Bligh Bank will not have a discernible impact on radar surveillance of and communication with shipping traffic.[195]

The *Milieu Effecten Rapport* was submitted to governmental authorities for review and approval to secure project authorization.[196] After careful consideration, the Belgian Government authorized the construction and operation of the Belwind Offshore Wind Farm.

Recently, The Royal Belgian Institute of Natural Sciences compiled a series of monitoring studies related to offshore wind farms sited in the Belgian part of the North Sea, including the Belwind offshore wind far.[197] Studies of construction activities during Phase One of the Belwind Offshore Wind Farm have confirmed that the project has not had significant environmental impacts:

- Macrobenthic species richness in the Bligh Bank project in 2009 was comparable to that observed in pre-implementation studies conducted in 2005 and 2008.[198]
- No significant impacts were detected on soft-sediment macrobenthos. Monitoring observed natural spatial and temporal variability for the present macrobenthic communities.[199]
- No significant variations have been observed in the natural turbidity regime.[200]
- The closure of the wind farm to bottom fisheries is expected to have a positive effect on the bottom fauna.[201]

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[193] *Id*. at XXIV- XXV.
[194] *Id*. at XXXVI.
[195] *Id.* at XXIX.
[196] Ecolas NV, MER Offshore Windmolenpark Bligh Bank, Non-Technical Summary (2007).
[197] *See* Royal Belgian Institute of Natural Sciences, *Offshore Wind Farms in the Belgian Part of the North Sea: Early Environmental Impact Assessment and Spatio-Temporal Variability* (Degraer et al. 2010).
[198] *Id.* at 6.
[199] *Id*. at 101.
[200] *Id*. at 34.
[201] *Id*. at 108.

- Epifauna, demersal fish and bentho-pelagic fish showed similar density patterns across baseline seasons and years in which monitoring occurred (2005 and 2008) and the deployment period (2009).[202]
- No significant impacts were detected on soft-sediment macrobenthos. Monitoring observed natural temporal variability for the present macrobenthic communities.[203]
- Compared to prior studies, the population with harbored a more positive attitude towards offshore wind farms, with approval increasing by 10% between 2002 and 2009.[204]

References:

- Environmental Impact Report and Government authorization for project available at http://www.mumm.ac.be/EN/Management/Sea-based/windmills_docs.php?proj=belwind
- Royal Belgian Institute of Natural Sciences monitoring studies available at www.mumm.ac.be/Downloads/mumm_report_mon_win2010.pdf

N. Dong Walney Ltd. – Walney Offshore Wind Farm (United Kingdom)

In April 2010, Dong Walney Ltd. (UK) began construction on an offshore wind farm of 450-600MW capacity, sited approximately 14km offshore of Walney Island, United Kingdom. The site chosen for the wind farm lies in an area of relatively shallow water, at some distance from the coast, but within British territorial waters. The location of the site represents a compromise between optimal wind resource, limited impact on fishing and shipping activities, optimal construction depths, and limited visual impacts.

Between 2004 and 2006, Dong Walney commissioned RSK ENSER Environment Ltd., an independent environmental consulting firm, to carry out comprehensive environmental studies as part of an overarching Environmental Impact Assessment for project authorization. These studies were intended to provide a baseline for the Walney Offshore Wind Farm environmental monitoring programs to compare environmental conditions prior and subsequent to installation.

In March 2006, RSK ENSER Environment prepared an Environmental Statement for the Walney Offshore Wind Farm.[205] While concluding that a few minimal environmental impacts may arise, the Statement's overall evaluation is that no significant impacts would arise as a result of installing and operating the Walney Offshore Wind Farm.[206] Specifically, the Statement found as follows:

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[202] *Id*. at 121.
[203] *Id*. at 101.
[204] *Id.* at 6.
[205] Dong Energy, Walney Offshore Windfarm Environmental Statement Non-Technical Summary (March 2006).
[206] *Id.* at 19.

- Construction, operation and decommissioning activities will produce only negligible impacts on the physical environment.
- The offshore wind farm will not leave a significant impact on the onshore environment. The impact on the terrestrial flora will be temporary and minor or negligible.[207]
- The offshore wind farm may have some localized impact on the marine environment in the immediate vicinity of the site, but impacts further away from the site are expected to be negligible. For example, construction activities may generate underwater noise that impacts marine mammals within 1000m of the pile-driving site, such as whales, dolphins and seals. However, noise impacts may be mitigated by utilizing tactics to scare sensitive mammals away before driving begins. [208]
- Studies revealed that only a few migratory bird species, such as the Whooper Swan and Pink-footed Goose, pass the site when migrating, and the impacts from collision and barrier effects were assessed to be negligible. Common Scoter fly over the site, but always at heights below the rotor blades. Accordingly, the risk of these ducks colliding with turbines is negligible. The impacts of the wind farm on all other bird species, including habitat loss and displacement, are negligible.[209]
- No special protected species will be affected by the wind farm.[210]
- Suspended sediment and the electromagnetic fields around the cables are expected to result in negligible effects on the marine environment, including bottom fauna, shellfish and fish.[211]
- A detailed visibility assessment concluded that, in views from the north along the western coastline of Cumbria from St. Bees to Bootle Fell, the visual effects were of minor to negligible significance. In closer distance views from the northern shoreline of the Duddon Estuary at Haverigg and along the western shoreline of Walney Island, the effects were assessed to be of moderate significance. For inland viewpoints, the effect was assessed to be of minor to negligible significance. In views from the east and the south, the significance of effects was assessed to be minor, whilst at Morecambe, Heysham and Blackpool the significance of effects was assessed to be negligible.[212]
- Based on implementation of detailed mitigation measures, the development of the offshore wind farm is expected to have no significant impact on important archaeological findings or sites of archaeological interest.

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[207] *Id.* at 19.
[208] *Id.* at 15.
[209] *Id.* at 15-17.
[210] *Id*. at 15.
[211] *Id.*
[212] *Id.* at 16-17.

- The noise generated by wind turbines during operation will not be audible from land. The waterborne noise will occasionally be significant during construction, but will not affect humans. Other activities will produce noise at negligible levels.[213]
- Based on implementation of detailed mitigation measures, cable routing is not expected to have a significant environmental impact.
    - The construction of the proposed cable route will have no impact on the existing marine flood defenses.[214]
    - The proposed cable route does not pass through any statutory or non-statutory conservation sites. However, the cable laying works could potentially have minor short term impacts on nesting birds if they coincide with the nesting season and cross scrub and hedgerows. If construction coincides with the nesting season, mitigation measures may include early scrub and hedgerow removal. The anticipated impact on nesting birds is thus negligible.[215]
    - The cable route will not cross any landfill sites, but will pass nearby two sites, such that artificial ground or contaminated land may be encountered during construction. When following working procedures established in conjunction with the Environmental Agency, potential impact is considered to be moderate.[216]

Of particular import in the Environmental Impact Assessment process for the Walney Offshore Wind Farm was consideration of the potential cumulative impacts of the project in conjunction with other offshore developments in the Morecambe area.[217] In particular, the environmental studies addressed four specific issues: navigation, birds, commercial fisheries and visual impact.

- The Environmental Impact Assessment considered navigational safety and passage concerns as a result of a parallel offshore wind farm developed by Vattenfall UK, the Ormonde combined wind and gas project. As a result of this project, the Walney site was moved a distance of 0.9 nm from its original site, reducing the cumulative navigational impact of the projects, including collision risk.[218]
- Due to cooperation between multiple wind farm developers, the Environmental Impact Assessment determined that the Walney Offshore Wind Farm would not make a significant contribution to any potentially significant cumulative ornithological effects of future developments.[219]

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[213] *Id.* at 14.
[214] *Id.* at 19.
[215] *Id*. at 18.
[216] *Id.* at 19.
[217] *Id.* at 10.
[218] *Id.* at 19.
[219] *Id.* at 16.

- As a result of multiple wind farm developments in the Irish Sea, studies determined that the Walney Offshore Wind Farm could contribute to a moderate cumulative impact on commercial fisheries. However, the Environmental Impact Assessment determined that the potential impact on fisheries could be mitigated through various initiatives, including introduction of alternative fishing methods to local fishermen and assistance in locating new fishing sites. On balance, the Environmental Statement determined that the residual overall loss of access to fisheries would be expected to have only a minor impact.[220]
- The Environmental Impact Assessment determined that, as a result of existing and anticipated wind farms proposed within the surrounding seascape, the Walney Offshore Wind Farm could contribute to a change in the overall visual character of the offshore area.[221] With increased development of offshore wind farms, the Walney Offshore Wind Farm would become part of "windfarm seascape."[222] However, such potentially significant effects would only arise in closer range views and would not arise in the short term.[223]

References:

- Environmental Statement, Non-Technical Summary, available at http://www.dongenergy.com/SiteCollectionDocuments/wind/Walney/Non_Technical_Summary.pdf

O. NaiKun Wind Development Inc. – NaiKun Offshore Wind Farm (Canada)

NaiKun Wind Development Inc., a Canadian renewable energy company, has proposed to develop an offshore wind project in shallow waters off the northeast coast of Haida Gwaii in British Columbia's Hecate Strait. The proposed project will be Canada's first offshore wind energy development off the northwest coast of British Columbia, and will include up to 110 wind turbine generators with a combined plant capacity of 396 MW and annual production of 1.3 GWh of renewable energy. Construction is set to commence April 1, 2012.

In December 2009, NaiKun Wind received an Environmental Assessment Certificate from the British Columbia Environmental Assessment Office, approving its proposed offshore wind energy project. Following consideration of environmental, social, economic, heritage and health effects, the Environmental Assessment Office prepared an Assessment Report,[224] which determined that the proposed Project would not result in any significant adverse effects. Specifically, the Assessment Report concluded as follows:

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[220] *Id.* at 12.
[221] *Id.* at 9.
[222] *Id.* at 16-17.
[223] *Id.* at 17.
[224] British Columbia Environmental Assessment Office, Naikun Offshore Wind Energy Project, Environmental Assessment Report (2009).

- The proposed project is not likely to have a significant adverse effect on the marine physical environment, including waves, littoral currents, sediment transport, scour, coastal erosion and deposition along the adjoining shorelines.[225]
- The proposed project is not likely to have a significant adverse effect on marine aquatic ecology, including the seabed and benthic habitats, noise and vibration effects, electromagnetic field impact, and hydrological conditions.[226]
- The proposed project is not likely to have a significant adverse effect on marine mammals.[227]
- The proposed project is not likely to have a significant adverse effect on marine birds.[228]
- The proposed project is not likely to have a significant adverse effect on terrestrial ecology, including freshwater fish habitat, vegetation and wildlife.[229]
- The proposed project is not likely to have significant adverse economic effects.[230]
- The proposed project is not likely to have significant adverse effects on communities and services.[231]
- The proposed project is not likely to have significant adverse effects on land use and tenure.[232]
- The proposed project is not likely to have significant adverse effects on visual resources.[233]
- The proposed project is not likely to have significant adverse effects on radio communications.[234]
- The proposed project is not likely to have significant adverse effects on navigation.[235]
- The proposed project is not likely to have significant adverse effects on archaeological and heritage resources.[236]
- The proposed project is not likely to have significant adverse effects on public health.[237]

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[225] *Id*. at 20-22.
[226] *Id*. at 24-33.
[227] *Id*. 34-38
[228] *Id*. at 38-42.
[229] *Id*. at 43-45.
[230] *Id*. at 50-53.
[231] *Id*. at 53-55.
[232] *Id*. at 55-57.
[233] *Id*. at 57-59.
[234] *Id*. at 59-60.
[235] *Id*. at 60-62.
[236] *Id*. at 62-65.

To support these findings, NaiKun has committed to environmental management plans for soil erosion, emergency spill response and contingency, waste management and disposal, health and safety, monitoring, qualitative risk, and environmental auditing.

References:

- Environmental Assessment Office Report available at http://www.llbc.leg.bc.ca/public/pubdocs/bcdocs/462169/1260491074280_e0bcf2b83da149389131d669c1cbcbc9ab092a32126ef8d13dfa771ae30c9e20.pdf
- Environmental Assessment Certificate and Government Recommendation available at: http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_project_doc_list_230_c_waa.html

VI. CONCLUSION

Based on the foregoing analysis, ARPA-E supports the addition of proposed categorical exclusion B5.25, "Small-scale renewable energy research and development and pilot projects in salt water and freshwater environments," to Subpart D of DOE's regulations implementing NEPA.

[237] *Id*. at 65-70.