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Introduction

Ocean Renewable Energy Coalition is the national trade association for marine and hydrokinetic renewable energy dedicated to promoting energy technologies from clean, renewable ocean resources. The coalition is working with industry leaders, academic scholars, and other interested NGO's to encourage ocean renewable technologies and raise awareness of their vast potential to help secure an affordable, reliable, environmentally friendly energy future.

We seek a legislative and regulatory regime in the United States that will accelerate the development of ocean renewable technologies and their commercial deployment. While other countries have already deployed viable, operating, power generating projects using the emission-free power of ocean waves, currents, and tidal forces, the U.S. is only beginning to acknowledge the importance these technologies.

Ocean energy can play a significant role in our nation's renewable energy portfolio. With the right support, the United States ocean energy industry can be competitive internationally. With the right encouragement, ocean renewable energy technologies can help us reduce our reliance on foreign oil—fossil fuels, in general—and provide clean energy alternatives to conventional power generating systems. And with the right public awareness, our coastline communities can use ocean renewables as a springboard for coastal planning that reflects the principles of marine biodiversity. Today, OREC will address the steps that we must take to realize the promise and potential of ocean renewables.

Is the resource there? Yes, and the resource is located near highly populated areas on the coast, placing fewer demands on already taxed transmission infrastructure.

Is the resource cost competitive? Not yet, but indications suggest a much shorter time to commercial viability than experienced by many other renewable technologies.

Is the resource environmentally friendly? Preliminarily yes. We already know that ocean renewables present some of the most potentially environmentally benign energy technologies available today—no air emissions, no fuel costs or associated mining or drilling effects, no fuel transportation costs. We are still learning about the effects of siting ocean renewable projects, though initial studies are showing minimal impacts. A Draft Environmental Impact Statement prepared by Finavera Renewables for its 1 MW Makah Bay project found no significant impacts; Ocean Power Technologies has received a "Finding of No Significant Impact" or FONSI from the U.S. Department of the Navy for its project in Hawaii; and most recently, Verdant Power, Inc. has been monitoring fish behavior at its Roosevelt Island Tidal Energy (RITE) facility in New York City since December of 2006 with no observations of fish strikes on their turbines. Verdant Power's experience began with two underwater turbines being installed and monitored by more than $2 million of fish monitoring equipment including a Didson sonar device that allows scientists and engineers to observe fish as they interact with turbines in the river. They have since installed six (6) turbines and continued monitoring. There are twenty-seven (27) different species of fish including herring and striped bass in this section of the East River. The project is presently producing one Mw/hr/day and scientists are watching the fish swim around the turbines with no fish striking any of the equipment.

As these are only early indications of how these technologies interact with the marine environment continued diligence is necessary to establish a thorough baseline of information.

Types of Technology

Ocean energy refers to a range of technologies that utilize the oceans or ocean resources to generate electricity. Many ocean technologies are also adaptable to non-impoundment uses in other water bodies such as lakes or rivers. These technologies can be separated into three main categories:

Wave Energy Converters: These systems extract the power of ocean waves and convert it into electricity. Typically, these systems use either a water column or some type of surface or just-below-surface buoy to capture the wave power. In addition to oceans, some lakes may offer sufficient wave activity to support wave energy converter technology.

Tidal/Current: These systems capture the energy of ocean currents below the wave surface and convert them into electricity. Typically, these systems rely on underwater turbines, either horizontal or vertical, which rotate in either the ocean current or changing tide (either one way or bi-directionally), almost like an underwater windmill or paddle wheel. These technologies can be sized or adapted for ocean or for use in lakes or non-impounded river sites.

Ocean Thermal Energy Conversion (OTEC): OTEC generates electricity through the temperature differential in warmer surface water and colder deep water. Of ocean technologies, OTEC has the most limited applicability in the United States because it requires a 40-degree temperature differential that is typically available in locations like Hawaii and other more tropical climates.

Offshore Wind: Offshore wind projects take advantage of the vast wind resources available across oceans and large water bodies. Out at sea, winds blow freely, unobstructed by any buildings or other structures. Moreover, winds over oceans are stronger than most onshore, thus allowing for wind projects with capacity factors of as much as 65 percent, in contrast to the 35-40 percent achieved onshore.

Other: Marine biomass to generate fuel from marine plants or other organic materials, hydrogen generated from a variety of ocean renewables and marine geothermal power. There are also opportunities for hybrid projects, such as combination offshore wind and wave or even wind and natural gas.

Q. 1 Please describe the potential for electric power generation from ocean renewables. How much energy could the ocean supply?

The US wave and current energy resource potential that could be credibly harnessed is about 400 TWh/yr or about 10% of 2004 national energy demand.

EPRI has studied the U.S. wave energy resource and found it to be about 2,100 TWh/yr divided regionally as shown in the figure below. Assuming an extraction of 15% wave to mechanical energy (which is limited by device spacing, device absorption, and sea space constraints), typical power train efficiencies of 90% and a plant availability of 90%, the electricity produced is about 260 TWh/yr or equal to an average power of 30,000 MW (or a rated capacity of about 90,000 MW). This amount is approximately equal to the total 2004 energy generation from conventional hydro power (which is about 6.5% of total 2004 US electricity supply).

EPRI has studied the North America tidal energy potential at fewer than a dozen selected sites. The tidal energy resource at those US tidal sites alone is 19.6 TWh/yr. Assuming an extraction of 15% tidal kinetic energy to mechanical energy, typical power train efficiencies of 90% and a plant availability of 90%, the yearly electricity produced at the U.S. sites studied is about 270 MW (average power, rated capacity is about 700 MW). EPRI estimates that the total tidal and river in stream potential is on the order of 140 tWh/yr or about 3.5% of 2004 national electricity supply.

Q. 2 Please describe the current state of ocean power technologies in the United States and around the world.

The status of US wave, current and tidal projects

At present, prototype offshore renewable projects are moving forward in the United States. These include the following:

- Finavera Renewables, Inc., has proposed a 1 MW pilot project for the Makah Bay off the coast of Washington state. The project is currently poised to complete a four-year permitting process at the Federal Energy Regulatory Commission. (FERC)

- New York based Verdant Power is undergoing licensing at FERC and deployed two of six units of a tidal/current project located in the East River of New York in December 2006. Verdant Power, Inc is in the process of deploying 4 more turbines scheduled for completion early May of 20007. These units will supply power to two commercial customers on Roosevelt Island imminently, once all regulatory clearances have been obtained.

- New Jersey based Ocean Power Technologies (OPT) has operated a test wave energy buoy off the coast of Hawaii for the U.S. Navy. It has also operated a buoy off the coast of New Jersey funded by Board of Public Utilities since 2005 and in July 2006, filed a preliminary permit for a commercial wave farm at Reedsport, off the coast of Oregon.

- ORPC Alaska, owned by Ocean Renewable Power Company (ORPC) of North Miami, Florida, recently secured Preliminary FERC permits for two sites in Alaska. ORPC Maine, also owned by ORPC, has applied for, and anticipates receiving very soon Preliminary FERC Permits for two sites in Maine. ORPC also has six Preliminary FERC Permits for sites off the east coast of Florida.

- Australian based Energetech, recently re-named to Oceanlinx Ltd, has formed a subsidiary in Rhode Island which has received funding from the Massachusetts Trust Collaborative and has planned a 750 kW project for Port Judith Rhode Island. Permitting has not yet commenced.

- Multiple permits for sites in Maine, California, Oregon, Alaska and Florida have been filed with the Federal Energy Regulatory Commission.

- The Mineral Management Service (MMS) now has authority to lease lands for offshore wind projects on the Outer Continental Shelf. MMS has conducted environmental review of the proposed 420 MW Cape Wind Farm off the coast of Nantucket, MA and LIPA/FPL 100 MW project off the coast of Long Island, NY.

Status of Ocean Renewable Projects Overseas

In Europe, projects are moving ahead. Europe has already installed 587 MW of offshore wind in Denmark, Holland, Scotland, England and UK. See http://www.bwea.com/offshore/worldwide.html.

Two near shore wave projects, are operating in Scotland and Isle of Azores. Pelamis of OPD in Scotland is deploying the world's first commercial wind farm off the coast of Portugal and Marine Current Turbines has operated a prototype tidal project for 2 years.

Q. 3 What is the consumer price, per kWh, of ocean generated electricity. What are the projections for reduction in that price.

Naturally, costs vary with the type of technology. The MMS Whitepaper on Offshore Wind states that where once the cost of offshore wind was around forty cents/kWH, over the past twenty years, costs have dropped to between 4 and 6 cents/kwh. By 2012 and beyond, DOE envisions 5 MW and larger machines generating power for 5 cents/kWh.

Cost estimates are more difficult for wave and tidal, which in contrast to offshore wind, lack operational history. For wave, costs have been estimated as between 9 and 16 cents/kWh, far more favorable than the 40 cents/kWH that offshore wind cost "out of the box." For instream tidal, the EPRI reports predicted costs as low as 6 to 9 cents/kWH because tidal power's similarities to wind allow it to benefit from the advancements already made by wind and potentially share economies of scale.

And, the costs of offshore wind or wave are stable. Whereas natural gas and oil have fluctuated over the years (with natural gas now higher than ever), offshore wind and wave energy costs are stable, since the cost of renewable power sources like wind or wave are free. The analogy here is that the **cost to consumers for renewable energy, free from the fluctuating costs of fuel, functions like a fixed-rate mortgage as opposed to a variable rate mortgage associated with the use of finite fossil fuel resources.**

Also, costs are expected to decline as the industry matures and as economies of scale make ocean projects less costly. As the offshore wind industry makes advancements on mooring systems, turbine durability and other issues that bear on the cost of marine projects, these advancements will help bring down the cost of other ocean energy technologies. In addition, if we can gain a better assessment of our resources, we can target the most powerful sites first and learn from our experience in these locations to bring costs down further.

It is important to note that non-technology costs associated with these types of projects will also be reduced as the industry matures. These include insurance and financing, as well as much needed and anticipated regulatory and permitting reform.

Q. 4 Is the United States behind other countries in the development of the technology? Is this a result of a lack of federal investment?

Yes, the United States has fallen behind countries like Scotland, Portugal, Norway, and others; however, we are on a track to quickly regain a leading position. Portugal offers a € .235/kWH [equivalent to nearly $.32 (US)] feed-in tariff. Compare this to the U.S., where the wind industry receives approximately $.019/kWH. and ocean renewables receive nothing. Britain pays substantial incentives including capital cost re-imbursements of 25 percent (25%). The United States needs to match these foreign incentives in order to attract and retain world class technology developers.

Permitting and regulatory obstacles are tremendous disincentives to companies developing ocean renewable projects in the United States, as well. While other countries have adopted permitting and regulatory regimes that appear to be more efficient, the United States is still struggling with exactly how to permit and regulate these technologies.

Q. 5 What kind of technological obstacles remain to the commercial viability of ocean power?

Advances in a number of other sectors have benefited the marine renewable industry sector including advanced materials, turbine design, and offshore construction. Listed below are the present day R&D requirements to support the development of marine and hydrokinetic technologies in the United States.

R&D Needs for the Ocean Renewable Energy Sector

(1) developing and demonstrating marine and hydrokinetic renewable energy technologies;
(2) reducing the manufacturing and operation costs of marine and hydrokinetic renewable energy technologies;
(3) increasing the reliability and survivability of marine and hydrokinetic renewable energy facilities;

(4) integrating marine and hydrokinetic renewable energy into electric grids;
(5) identifying opportunities for cross fertilization and development of economies of scale between offshore wind and marine and hydrokinetic renewable energy sources;
(6) identifying the environmental impacts of marine and hydrokinetic renewable energy technologies and ways to address adverse impacts, and providing public information concerning technologies and other means available for monitoring and determining environ mental impacts; and
(7) standards development, demonstration, and technology transfer for advanced systems engineering and system integration methods to identify critical interfaces.

Specific R&D tasks

Wave Power

1. Technology road mapping
2. Resource characterization – Data and models to identify "hot spots"
3. Hydrodynamics – mathematical and physical modeling including arrays (especially non linear and real fluid effects)
4. Control systems and methods for optimum performance (while ensuring survivability)
5. Power take off systems/smoothing especially direct drive
6. Materials – low cost
7. Materials, corrosion and biofouling
8. Construction methods – low cost
9. Performance specification standardization and test verification
10. Low cost moorings/deployment/installation/recovery methods

11. Ultra high reliability components (for minimum maintenance cost)
12. Electrical grid connection
13. System configuration evaluations (which are best under what circumstances)
14. Module size versus cost of electricity sensitivity
15. Results from pilot tests (especially to reduce cost and environmental impacts uncertainty)

Tidal Power

1. Technology road mapping
2. Resource characterization – Data and models to identify "hot spots" given complex bathymetry and turbulence
3. Hydrodynamics – mathematical and physical modeling including arrays (especially non linear and real fluid effects) and an evaluation of the efficacy of diffusers (i.e., ducted water turbine)
4. Control systems and methods for optimum performance
5. Power take off systems/smoothing especially direct drive
6. Materials – low cost
7. Materials, corrosion and biofouling
8. Construction methods – low cost
9. Performance specification standardization and test verification
10. Low cost moorings/deployment/installation/recovery methods
11. Ultra high reliability components (for minimum maintenance cost)
12. Electrical grid connection
13. System configuration evaluations (which are best under what circumstances)
14. Module size versus cost of electricity sensitivity
15. Results from pilot tests (especially to reduce cost and environmental impacts uncertainty)

Q. 6 What can Congress and/or the federal government do to help move the technology forward? Is there a role for federal support for R&D? Why is federal spending necessary?

The first thing Congress can do is pass designed to accomplish the following::

--More funding for R&D and technology development: Wind energy has benefited from substantial government investment. Thirty years ago, wind cost 30 cents/kWH to generate; today, that cost stands at 3 to 7 cents/kWH. And even today, DOE continues to invest in wind. Just a few months ago, DOE announced a $27 million partnership with GE to develop large-scale turbines and also issued a $750,000 SBIR to Northern Power for offshore wind technology development.

Private developers have borne the costs of bringing the ocean energy technology forward for the past thirty years, but they need government support. Government funding will also give confidence to private investors and help attract private capital.

--Resource Assessment: At present, we do not even know the full potential of offshore renewables, because no agency has ever mapped the resource comprehensively.

The Energy Policy Act of 2005 directed the Secretary of DOE to inventory our renewable resources but that work has never been funded. And even as MMS moves forward with a rulemaking for offshore renewables on the OCS, it has not received appropriations to map the resource.

Preliminary studies done by EPRI and private companies show that we have substantial ocean resources. But we will not know the full scope without further mapping and study.

--Incentives for Private Investment: Offshore renewables are compatible with other large industries in our country, such as oil and maritime industry. These industries, with the right tax incentives, can provide substantial support to offshore renewable development. Incentives could include investment tax credits for investment in offshore renewables and incentive to use abandoned shipyards and decommissioned platforms for prototypes and demonstration projects.

--Incentives for coastal communities: Coastal municipalities stand to gain tremendously from installation of offshore renewables. They need to be stakeholders in the process with a voice in development that takes place off their shores. Congress can support this by continuing to authorize Clean Renewable Energy Bonds (CREBS) and the Renewable Energy Portfolio Incentives (REPI) for coastal projects.

--Reduced regulatory barriers: Until companies get projects in the water, we will not learn about the environmental impacts or true costs of offshore renewables. Unfortunately, developers face onerous barriers to siting small, experimental projects. We should establish streamlined regulation and permitting for offshore renewables, with maximum cooperation between state and federal agencies.

Conclusion

Development of a robust offshore renewables industry can:

- Reduce reliance on foreign oil
- Rely upon ocean terrain for power generation as opposed to onshore land resources
- Revitalize shipyards, coastal industrial parks and shuttered naval bases
- Create jobs in coastal communities
- Allow the US to transfer technology to other countries, just as a country like Scotland is exporting its marine renewables know-how

- Provide low cost power for niche or distributed uses like desalination plants, aquaculture, naval and military bases, powering stations for hybrid vehicles and for offshore oil and gas platforms

- Provide use for decommissioned oil platforms through "rigs to reefs program"

- Promote coastal planning that reflects the goals of bio-diversity, that maximize best comprehensive use of resources and capitalizes on synergies between offshore industries

Is the resource there? Yes, and the resource is located near highly populated areas on the coast, placing fewer demands on already taxed transmission infrastructure. The United States cannot afford to ignore

Ocean renewables can help diversify our energy portfolio and improve our environment. With the proper support, these resources will become a robust part of a reliable, affordable, clean electric supply portfolio.