Testimony

Marine and Hydrokinetic Technologies: Finding the Pathway to Commercialization

U.S. House of Representatives

Committee on Science and Technology

Subcommittee on Energy and Environment

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Thank you, Chairman Baird, Ranking Member Mr. Inglis and Members of the Committee

I am Roger Bedard, Ocean Energy Leader for the Electric Power Research Institute (EPRI), a non-profit, collaborative R&D organization. EPRI has principal locations in Palo Alto, California, Charlotte, North Carolina, and Knoxville, Tennessee. EPRI appreciates the opportunity to provide testimony to the Energy and Environment Subcommittee on the topic of "Marine and Hydrokinetic (MHK) Technologies; Finding the Pathway to Commercialization."

In 2004, EPRI initiated technical and economic feasibility studies of ocean wave energy. We followed these studies with tidal hydrokinetic studies in 2006 and river hydrokinetic studies in Alaska in 2008. These studies have resulted in a substantial nationwide momentum towards adding MHK technologies to our national portfolio of energy supply alternatives. One measure of this momentum is the large number of preliminary permit applications filed by industry with the Federal Energy Regulatory Commission for the development of MHK power generation projects which reference the EPRI studies.

I will focus my comments today on four key points:

- First, the wave and tidal hydrokinetic energy resource available to the U.S. which can be converted to electricity is significant;
- Second, the technology to convert those resources to electricity is emerging and is ready for testing in the ocean;
- Third, wave and tidal hydrokinetic energy can be cost competitive with other renewable technologies in the future; and
- Fourth, significant challenges remain to finding the pathway to commercialization of MHK energy technologies.

The key message that I hope you will take away from my testimony is that MHK energy is a renewable resource that we as a nation should seriously consider as an addition to our national portfolio of energy supply alternatives and that this consideration requires Government support and incentives as it has with other energy technologies in the past.

Background

The idea of harnessing the vast power of Earth's oceans has fascinated and tantalized humans for centuries. Today, we may be on the cusp of realizing this potential and enabling that to happen in the U.S. is within your jurisdiction.

Marine and hydrokinetic (MHK) technologies is a term used by the U.S. Congress to describe the conversion of ocean wave potential and kinetic energy, in-stream tidal, open-ocean and river current kinetic energy, and ocean thermal energy conversion It excludes offshore marine wind kinetic energy, does not mention ocean salinity gradient energy and should not be confused with conventional hydropower using a dam, impoundment or diversionary structure.

EPRI believes that a robust electricity system of the future will be a balanced and diversified portfolio of energy supply alternatives. Our nation has investigated many if not all known electricity supply alternatives (including space-based power; i.e., photovoltaic panels in orbit beaming power to large antennas on Earth) except for one; our oceans (with two exceptions, a large ocean thermal energy conversion program in the 1980s and a more modest open-ocean current program in the 1970s). Our oceans are a public resource held in trust and accommodating multiple users; fisherman make their living from the ocean, commercial shipping navigates the oceans to deliver goods, recreational boaters, surfers and those who just walk on the beach enjoy the ocean and whales and other living creatures make the ocean their home. Ocean energy could be one of those users working in harmony with other users and providing renewable energy for the overall good of our society.

WAVEBOB

Some of the Benefits of Marine and Hydrokinetic Energy

The advantages of ocean energy are numerous. First and foremost is a potential for costs that are competitive or lower than that of other renewable technologies. EPRI studies indicate that the high power density (kW/m2 for currents and kW/m of wave crest length for wave) of the MHK resource results in smaller and stronger energy conversion machines lower in capital cost than for other renewable technologies. The remoteness and at times, hostility of the ocean environment, however, results in higher deployment, operation and maintenance cost, but on balance, the cost of electricity can be comparable or lower than that with other renewable technologies. Other benefits include: 1) providing a new, environmentally friendly, renewable energy source for meeting load growth and legislated Renewable Portfolio Standard requirements; 2) easily assimilated into the grid (because of the predictability of the resource), 3) easing transmission constraints (since a large percentage of our population lives near the coast) with minimal, if any, aesthetic concerns; 4) reducing dependence on imported energy supplies and increasing national energy security; 5) reducing the risk of future fossil fuel price volatility; 6) reducing emissions of greenhouse gases as compared to fossil fuel-based generation; and 7) stimulating local job creation and economic development by using an indigenous resource.

Existing industries in the U.S. such as ship building are looking for opportunities to diversify, grow, and compete. These industries provide a trained workforce and institutional knowledge that will benefit ocean renewable energy technologies while helping to re-vitalize their own sectors.

The economic opportunities are significant. A relatively minor investment today could stimulate a worldwide industry generating billions of dollars of economic output and employing thousands of people while using an abundant and clean natural resource.

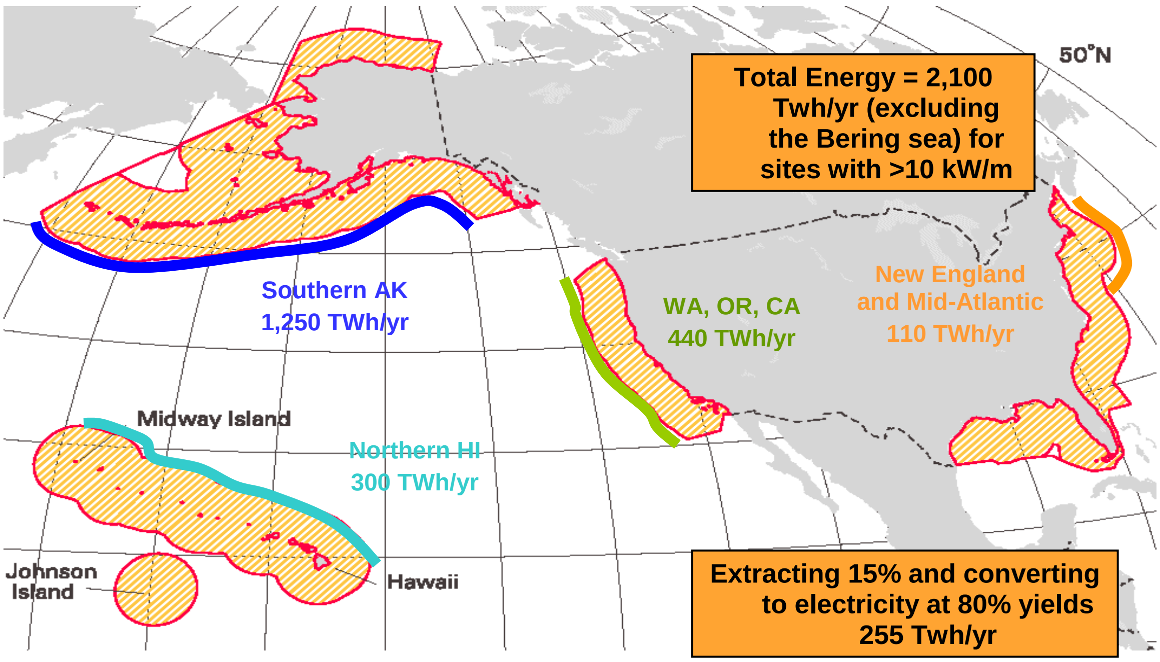
EPRI's Experience

EPRI's ocean energy experience is with wave and in-stream tidal and river hydrokinetic energy. In 2004, we initiated system definition technical and economic feasibility studies of ocean wave energy. At that time, the DOE was only able to provide in-kind services support to the EPRI efforts from the wind technology program at the National Renewable Energy Laboratory (NREL), which had an off shore component addressing related technical, environmental and regulatory issues. Under the leadership of Dr. Robert Thresher, Director of the National Wind Technology Center, NREL has provided valuable in-kind services and we continue working together today. EPRI followed the 2004-2005 wave energy studies in 2006 - 2007 with tidal in-stream studies and in 2008 - 2009 with river in-stream studies in Alaska (over 50 reports are available on our public website www.epri.com/oceanenergy/). The EPRI studies have resulted in a substantial nationwide momentum. One measure of this momentum is the large number of preliminary permit applications filed with the Federal Energy Regulatory Commission by industry for the development of MHK power generation projects in the U.S.

The Ocean Wave and In-Stream Tidal Currents, Open Ocean Currents and River Currents Hydrokinetic Energy Resource

Available Ocean Wave Energy Resource

EPRI has estimated the U.S. wave energy resource using decades of measurements by NOAA and Scripps data buoys. We estimate the available wave energy resource to be about 2,100 TWh/yr (for all state coastlines with an average annual wave power flux > 10 kW/m). This energy is divided regionally as follows:



Practical Ocean Wave Energy Electrical Energy Potential

The amount of that available wave energy that can be converted into electrical energy is not known given the uncertainties of societal, device spacing, conflicts of sea space and environmental limits.

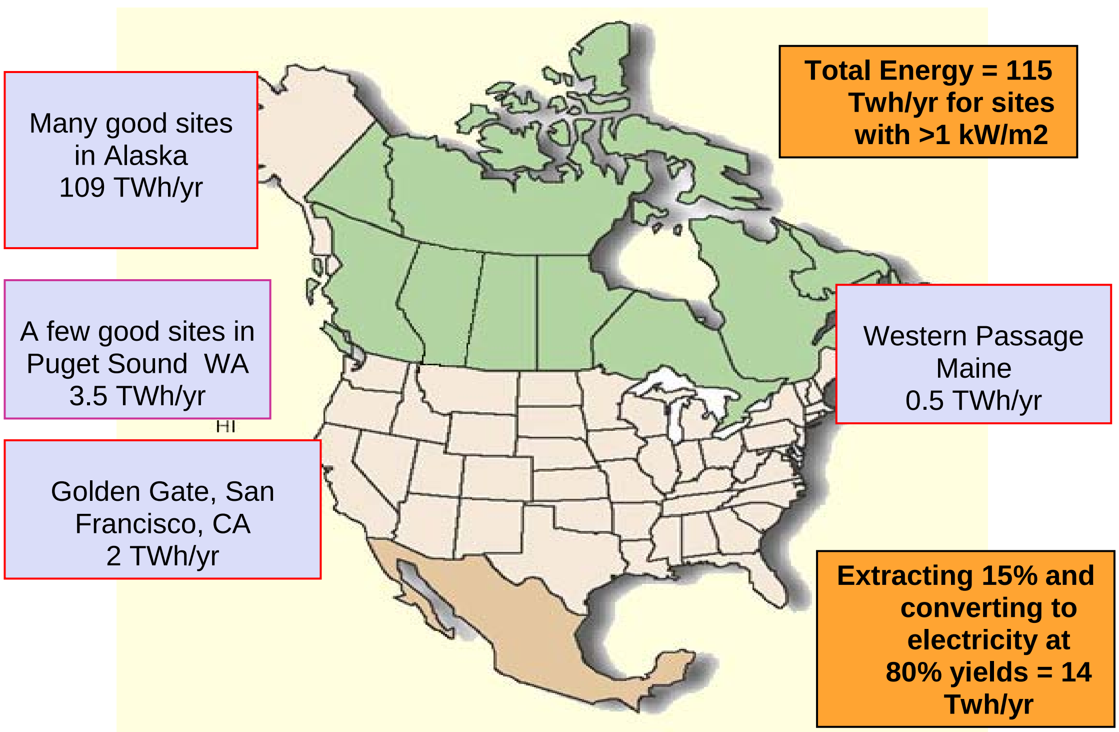
A preliminary estimate can be made by assuming absorption of 15% of the total available wave energy resource, a power train conversion efficiency of 90% and a plant availability of 90%. The electricity produced using this assumption is about 255 TWh/yr or equal to an average annual power of about 30 GW. The rated power is about 90 GW given a typical capacity factor of 33%. This amount of energy is comparable to the total energy generation from all conventional hydro power, or about 6.5% of current U.S. electricity consumption. This is significant.

Early wave plants must be built-out in phases with environmental monitoring and an adaptively managed process to larger size plants so that the cumulative effects of these larger plants stay within societal limits of acceptability

EPRI, teamed with NREL and Virginia Tech, has received grant funding from the DOE to perform a rigorous evaluation of the nation's available ocean wave energy resource and practical electrical energy generation potential. This work is scheduled for completion in 2010.

Available In-Stream Tidal Currents Hydrokinetic Energy Resource

Tidal in-stream hydrokinetic energy resources are not as well understood as wave energy resources. Economically viable hydrokinetic tidal energy sites typically occur in narrow passageways between oceans and large estuaries or bays. EPRI has studied many but not all potential U.S. tidal energy sites. The tidal energy resource at a single transect for those sites evaluated by EPRI to date is estimated at 115 TWh/yr with 6 TWh/yr at sites in the continental U.S. and the remaining 109 TWh/yr in Alaska. Tidal hydrokinetic energy resources may be locally important resources for the following regions in the lower 48 states; Maine, New York, San Francisco and Washington's Puget Sound.



The 115 TWh/yr estimate excludes sites with annual average power densities less than 1 kW/m2. If in-stream energy conversion device technology is economical at power densities less than 1 kW/m2, then the available resource in the lower 48 states could be much larger. These estimates should be considered as the lower bound of the tidal hydrokinetic resource because not all the U.S. tidal sites with potential have been evaluated.

Practical In-Stream Tidal Currents Hydrokinetic Electrical Energy Potential

The amount of the available tidal hydrokinetic energy resource that can be converted to electrical energy is not known given the uncertainties in societal, physical, ecological and environmental limits. We understand how to estimate the kinetic energy resource across a particular transect at a particular site, however, we have learned that this estimate is a poor predictor of both the maximum possible level of extraction for that site as well as the environmental impacts of extracting kinetic energy from that site. From a purely physical standpoint, depending on the limitations of seabed space within the high-velocity transects and the requirement to maintain adequate navigation clearance, the number of turbines that could be sited within a constrained channel is known given a maximum packing fraction for turbines. However, this could be limited to even lower levels of extraction by the ecological implications of changing the tidal regime by extracting kinetic energy from the flow. There is a self-limiting point at which it will not be economic to add additional turbines to an array since extraction reduces the available kinetic energy. It is unclear whether the available space, social and environmental pressures, or economics will pose the most stringent limits on resource extraction.

Furthermore, our current understanding of how extracting hydrokinetic energy at one site would affect the availability of hydrokinetic energy at another site within the same estuary or bay is insufficient to perform a resource estimate for an entire bay system.

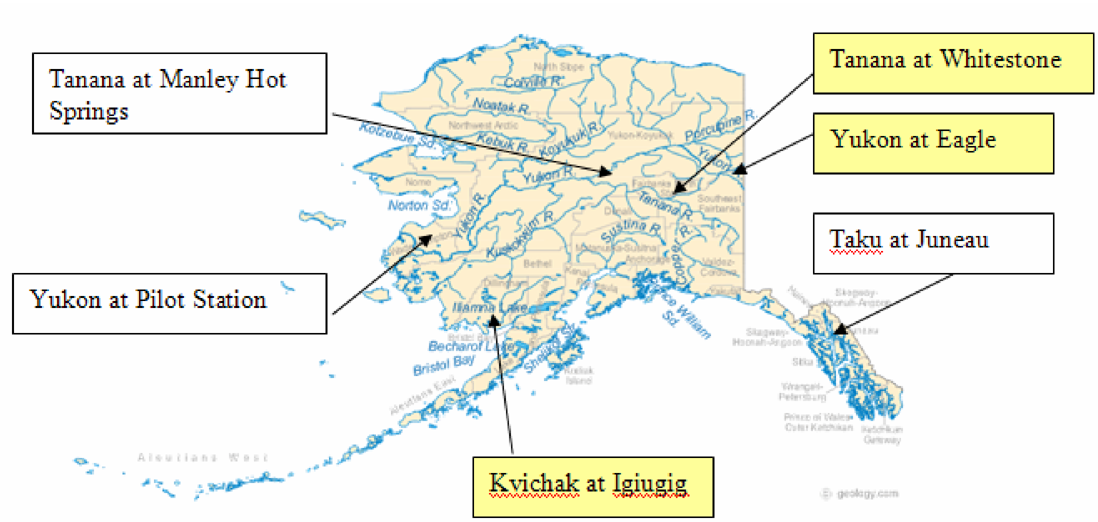
A conservative assessment of the deployment potential can be made by assuming absorption of 15% of the total available tidal hydrokinetic resource at a single transect of a tidal passageway (serving as a conservative proxy for the limiting factors discussed above), a power train efficiency of 90%, and a plant availability of 90%. The electricity produced using this assumption for the sites studied by EPRI is about 14 TWh/yr. This corresponds to an average annual power of 1,600 MW and a rated power of about 4,800 MW given a typical capacity factor of 33%. These estimates should be considered as the lower bound of the tidal hydrokinetic resource because not all the U.S. tidal sites with potential have been evaluated.

Georgia Tech has received grant funding from the DOE to perform an assessment of the energy production potential from tidal streams in the U.S. This work is scheduled for completion in 2010.

Available In-Stream River Current Hydrokinetic Energy Resource and Practical In-Stream River Current Hydrokinetic Electrical Energy Potential

A study carried out by New York University (NYU) graduate students in 1986, using a set of assumptions which were stated to be conservative, reported that about 110 TWh/year (average power of 12,500 MW) could be extracted from rivers using in-stream hydrokinetic energy conversion and that the majority of the nation’s river hydrokinetic energy resource is in the Pacific Northwest and Alaska. Significant rivers in the continental U.S. are illustrated below

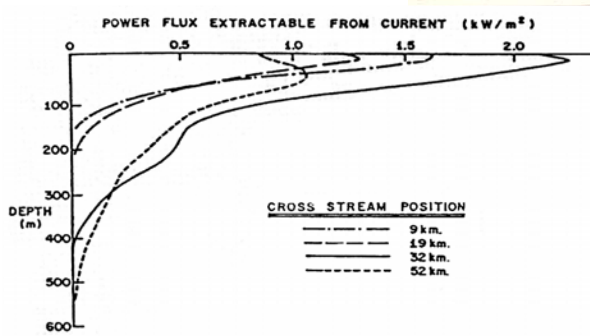
System definition and feasibility studies performed by EPRI in 2008-2009 showed that river in-stream hydrokinetic energy may be a feasible resource option for remote village electrification. EPRI surveyed six sites shown in the figure below and performed system definition and techno-economic feasibility studies for the three sites shown in yellow. Two pilot projects (Yukon River at Eagle and Kvichak River at Iguigig) are now underway at remote villages in Alaska, one funded by the Denali Commission and the other funded by the State of Alaska Renewable Energy Fund.



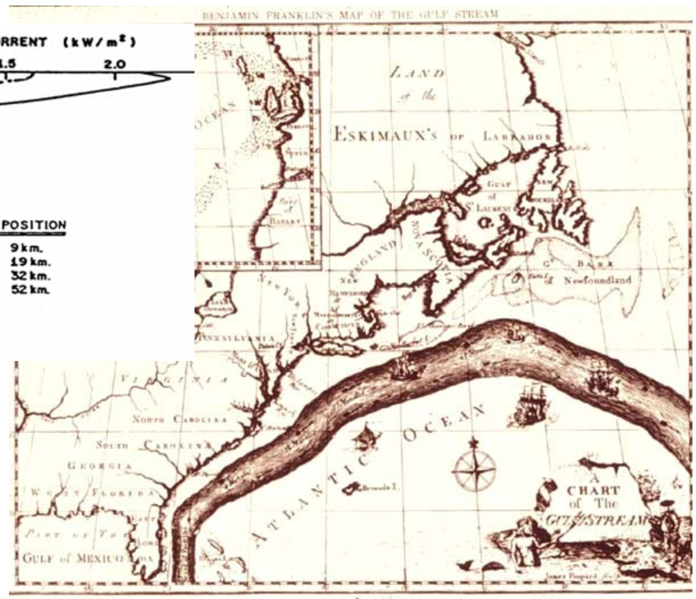
EPRI, teamed with NREL and the Universities of Alaska at Anchorage and Fairbanks, was recently selected by the FY2009 DOE Waterpower program for negotiation leading to award to assess the nation's river in-stream hydrokinetic resources and was also recently selected to perform desktop and laboratory flume studies that will produce information needed to determine the potential for injury and mortality of fish that encounter hydrokinetic turbines of various designs. Behavioral patterns will also be investigated to assess the potential for disruptions in the upstream and downstream movements of fish.

Available Open Ocean Current Resource and Practical Ocean Current Electrical Energy Potential

The primary open-ocean current resource available to the U.S. is located about 30 km off the shores of Southern Florida. The total available resource is not known, however, both Aeroviroment in the 1970s and recently Florida Atlantic University have estimated a practically recoverable electrical energy of 50 TWh/yr and an average annual power of about 10 GW (a capacity factor of 57%). Other ocean currents are typically located too far from shore or are too slow in current speed to provide for practical or economical transmission of power to load centers.



Average Florida Current power density profiles from Aerovironment studies funded by U.S. DOE for *Coriolis* Project



Georgia Tech was recently selected by the FY2009 DOE Waterpower program for negotiation leading to award to assess the nation's open-ocean hydrokinetic resources.

Resource Summary

Research by EPRI suggests that ocean wave and in-stream tidal hydrokinetic energy resource is location specific and that the total electrical energy production potential is equal to about 10% of the present U.S. electricity consumption (or about 400 Twh/yr). The most significant of these resources is wave energy and the locations in the U.S. with the most economically viable wave energy resource are Hawaii, Alaska and the Pacific Northwest (as far south as Point Conception which is just north of Santa Barbara, California)

While this preliminary assessment provides a good first order indication of the resource potential, it is important to understand that many factors, such as electrical transmission capabilities, economic viability, environmental concerns and socio-economic considerations may impose additional limits onto these resources that may substantially alter full development potential. Given the present technical, environmental and economic uncertainties, it is important to pursue all MHK resources in a sensible and strategic manner.

Status of Ocean Wave and In-Stream Tidal, Open Ocean and River Current Energy Conversion Technology

Ocean Wave Energy Conversion Technologies

Today's wave energy conversion technologies are the result of many years of testing, modeling and development by many developer organizations. Total capacity deployed to date is about 4 MW worldwide, and most of the devices are engineering prototypes. The first shore-based grid-connected wave power unit was a system built into the coastline of the Island of Islay in Scotland in 2000. In 2003, WaveDragon of Denmark was the first offshore grid-connected wave power unit and was deployed in a protected bay due to its subscale design. The following year (2004), Pelamis of the U.K. was the first full-scale, offshore, grid-connected wave power unit deployed in open seas at the European Marine Energy Center (EMEC) in the U.K. Based on successful testing at EMEC, the first commercial sale of an offshore wave power plant was announced by Pelamis Wavepower in May 2005 and the first 2.25 MW of that plant was deployed off the coast of Portugal in 2008. Unfortunately, the primary project investor, Brown and Babcock, recently declared bankruptcy and the project is now on hold pending further investment capital.

A number of demonstration projects are ongoing and planned in the U.K, Ireland, Spain, Portugal, China, Japan, Australia, Canada, and the United States. If these early demonstration projects prove successful, medium-size wave farms up to 30-50 MW in capacity could be deployed within the next five to eight years.

Ocean Power Technologies Point Absorber

OceanLinx Oscillating Water Column

Pelamis Linear Attenuator

Wave Dragon Overtopping

a) PowerBuoy, courtesy of Ocean Power Technology, b) OWC, courtesy of OceanLinx c) Pelamis, courtesy of Pelamis Wave Power, and d) WaveDragon, courtesy of WaveDragon,

Tidal In-Stream Energy Conversion Technologies

Today's tidal in-stream energy conversion technologies, much like wave energy technologies, are the result of many years of testing, modeling and development by many developer organizations. Total capacity deployed to date is about 3 MW worldwide, and most of the devices are engineering prototypes. The first grid-connected power units were built and installed in the U.K. and Norway.

A number of demonstration projects are ongoing and planned in the U.K, Norway, Sweden, France, Italy Korea, New Zealand, Canada, and the United States. The first commercial in-stream tidal power plant has yet to be realized.

Verdant Power

Lucid Energy

Ocean Renewable Power Corp

a) East River Roosevelt Island Tidal Project Axial Turbine courtesy Verdant Power, b) Gorlov Vertical Turbine courtesy Lucid Energy and c) Cross Flow Turbine courtesy Ocean Renewable Power Corp

River In-Stream Energy Conversion Technologies

Today's river in-stream energy conversion technologies are scaled down versions of larger tidal water turbines. Unlike wind turbines where the cost has come down as the sizes get larger, river in-stream developers hope to achieve cost reductions through high volume production of small machines, typically constrained in size due to river depth limitations and navigation requirements.

Two river in-stream turbines have been deployed in the U.S.; a 5 kW hydrokinetic turbine in the Yukon River in Alaska and a 40 kW hydrokinetic turbine deployed downstream of the hydro potential turbines at a conventional hydroelectric dam in Hastings, Minnesota.

Open Ocean Current Energy Conversion Technologies

Today's open-ocean current energy conversion technologies are similar to tidal and river in-stream technologies but with the potential of being very large in size due to the depths of the ocean. The 1970s Coriolis water turbine design diameter was 170 meters.

The first commercial in-stream open-ocean power plant has yet to be realized.

Energy Conversion Summary

There are many technology developers with different conceptual MHK energy conversion devices and those devices are at various stages of development. The time period for a MHK technology to progress from a conceptual level to deployment of a long-term full-scale prototype tested in the ocean is typically on the order of 5 to 10 years. The technology is still in its emerging stage; like where wind technology was approximately 15 to 20 years ago. It is too early to know which technology will turn out to be the most cost-effective, reliable, and environmentally sound, but it is likely that many different MHK technologies will play a role in our energy future.

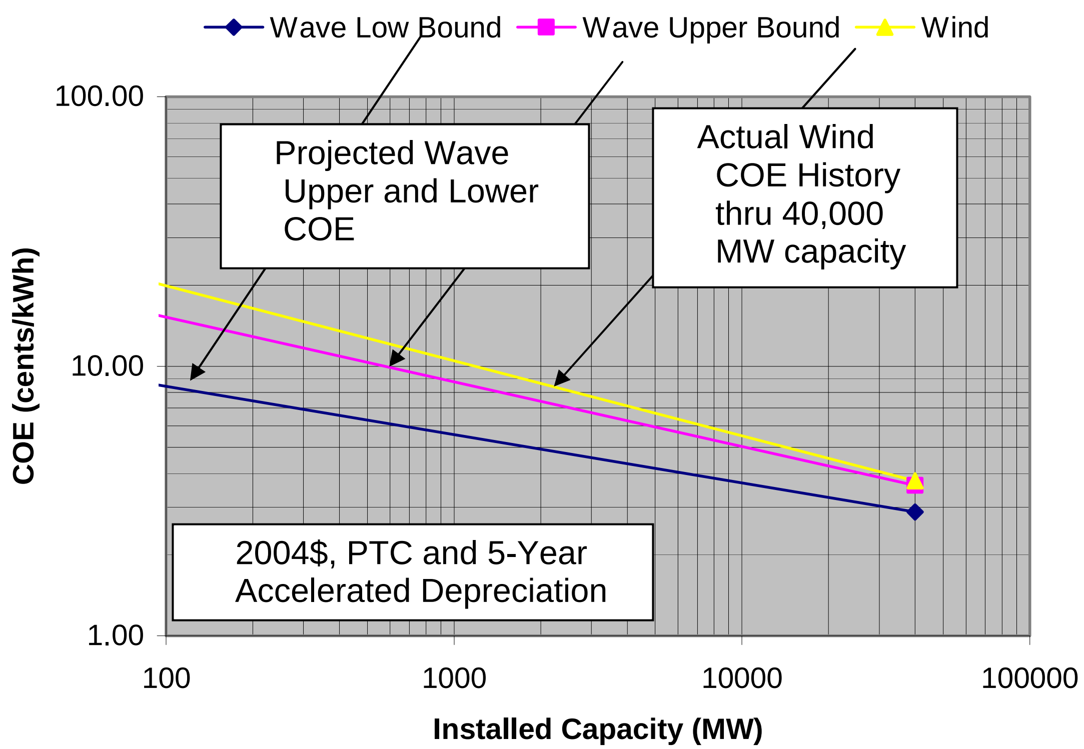
Of the many technology developers (greater than 50 each for wave and marine water turbine hydrokinetic machines), only a few dozen have progressed to rigorous subscale laboratory tow or wave-tank model testing. Only two dozen have advanced to short-term (days to months) subscale tests in the ocean. Even fewer have progressed to long-term (>1 year) testing of a full-scale prototype systems in the ocean. Pre commercial "pilot demonstration power plants" are needed to address critical concerns about reliability, maintainability, environmental issues and costs.

Status of MHK Power Projects and their Economic Competitiveness

Today, a large number of small companies, backed by government organizations, private industry, utilities, and venture capital, are leading the commercialization of technologies to generate electricity from ocean wave and tidal, river and open-ocean current resources. A small number of companies are leading the commercialization of ocean thermal gradient (and salinity gradient) energy technologies.

Over two decades ago, wind technology was beginning its emergence into the commercial marketplace at a busbar cost of electricity (CoE) in excess of 20 cents/kWhr (in 2004$ with production credits and 5-year accelerated depreciation). The historical wind technology CoE as a function of cumulative production thru 40,000 MW of cumulative production capacity deployed through 2004 is shown in the figure below. Wind technology experienced an 82% learning curve (i.e., the cost has reduced by 18% for each doubling of cumulative installed capacity). Over 1,500 MW of wind has now been installed worldwide. EPRI studies performed in 2004/2005 project indicate that wave energy will enter the market place at a lower entry cost than wind energy did and will progress down a learning curve that is similar to that of wind energy. The wave energy industry has the advantage of higher power densities compared to wind energy and therefore should have lower capital cost. The challenge to the wave energy industry will be to develop cost effective deployment and high reliability operation and maintenance technologies with low costs. Otherwise, the cost of deploying and operating these machines in a remote, and sometimes, hostile environment will outweigh the initial capital cost advantages and the CoE may not be competitive with other options.

The CoE is now approximately 7 cents/kWhr (in 2009$ with no incentives) for an average 30% capacity factor wind plant. Today, MHK technology status can be compared to wind 15 to 20 years ago; close to starting its emergence as a commercial technology.



Government Support of Marine and Hydrokinetic Research, Development and Demonstration (RD&D) and Commercialization

The European Union (UK, Ireland, Denmark, Norway, Sweden, France, Spain, and Portugal) is leading the development and commercialization of emerging marine and hydrokinetic energy technologies. Their support to accelerate this development includes:

- Supporting the technology developers with funding
- Funding subscale and full scale test facilities
- Establishing goals for commercialization
- Developing roadmaps that point out the pathways to meet these goals
- Providing financial incentives necessary to meet those goals

The Europeans have a 10 year head start on us in developing MHK technology.

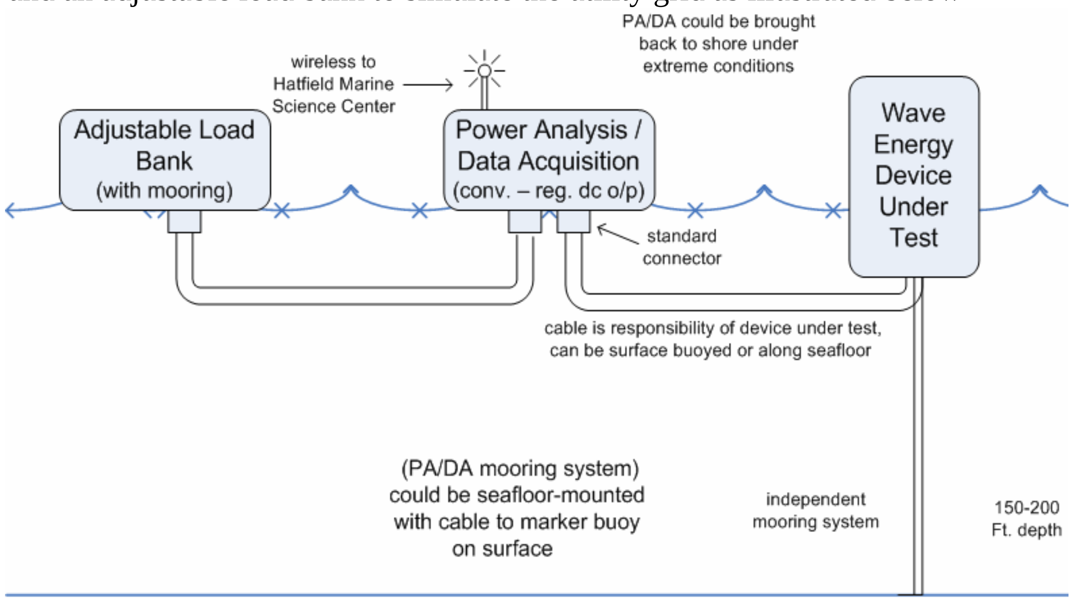
Other nations are also starting to engage in MHK energy. In Canada for example, EPRI performed in-stream tidal system definition and feasibility studies in the Bay of Fundy (Nova Scotia and New Brunswick). Our 2006 studies resulted in an immediate announcement by Nova Scotia Power for a multi million dollar tidal pilot demonstration project in the Minas Passage. This project is now funded at $70 million and the first of three large scale (1 MW class) machines has been deployed. Two other tidal machines as well as the submerged transmission cable will be deployed in 2010.

In the U.S., DOE manages a Waterpower RD&D program which began in FY2008 at $10 million, increased to $40 million in FY2009 and to $50 million in FY2010. This DOE program is funding many projects, including some of the EPRI work already discussed, but I will limit my testimony to one managed by universities and two managed by utilities which address a critical need; the need to test this new technology. Currently, the U.S. marine energy industry is challenged by the lack of proper and standardized infrastructure to deploy and test wave energy conversion devices in the ocean. Testing of these new devices needs to be done at scales that vary from small scale devices in subscale test facilities, to full scale ocean testing of prototype machines and to demonstration testing of pilot power plants. We are starting to make progress and sustaining this progress with long-term and consistent support is essential for building a globally competitive U.S. industry.

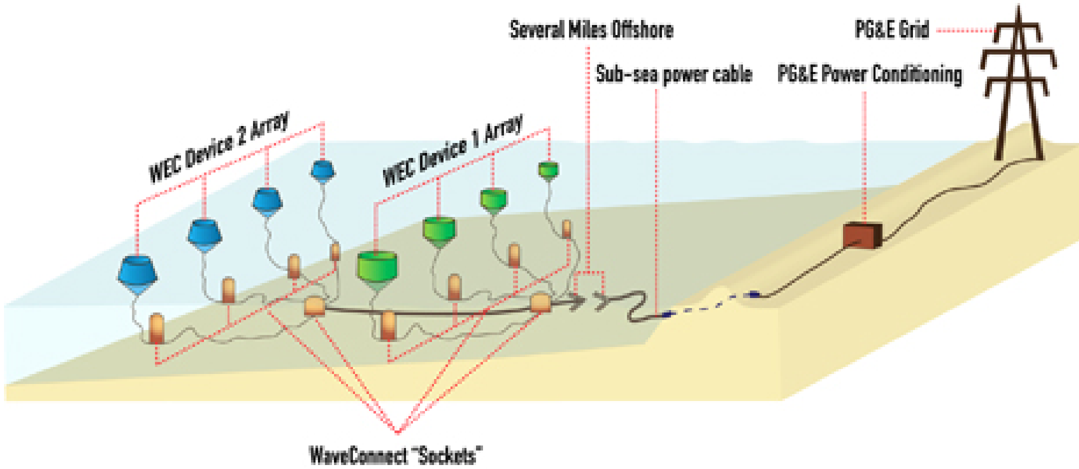
1). The Northwest National Marine Renewable Energy Center (NNMREC) is a DOE-funded partnership between Oregon State University (OSU) the University of Washington (UW) and the National Renewable Energy Lab (NREL). The University partition of responsibilities is as follows:

- OSU is responsible for wave energy research and development.
- UW is responsible for in-stream tidal energy research and development.
- Both universities collaborate on research, education, outreach, and engagement.

The NNMREC at OSU will provide wave energy conversion system developers with test berths to perform ocean testing, demonstration and advancement of sub-scale and full-scale devices. The first phase ocean test berths will be "mobile", with future plans to include both mobile and grid connected capabilities. The mobile ocean test berths (MOTBs) will consist of a power analysis and data acquisition (PADA) device and an adjustable load bank to simulate the utility grid as illustrated below



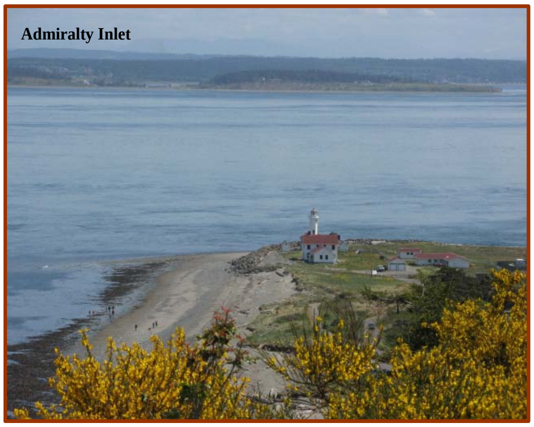
2) Pacific Gas and Electric (PG&E) WaveConnect – PG&E is the largest investor owned utility in the country and its service territory includes about 600 miles of high wave energy coastline. PG&E seeks to complete final design, stakeholder outreach and permitting of two 5 MW pilot ocean wave demonstration plants in this current phase of the project. The next phase of the project will include building an undersea electrical grid connection several miles offshore. This "offshore electrical cable and socket" will connect wave energy converters from multiple vendors to the PG&E electrical grid (similar to the U.K. Wave Hub funded by the UK government) and provide for testing and evaluation of the devices for commercial deployment. The current final design and permitting phase of the project is supported through PG&E ratepayer funding (80%) and by the DOE (20%). A greater level of Federal Government support may be needed once the project enters into the construction phase.

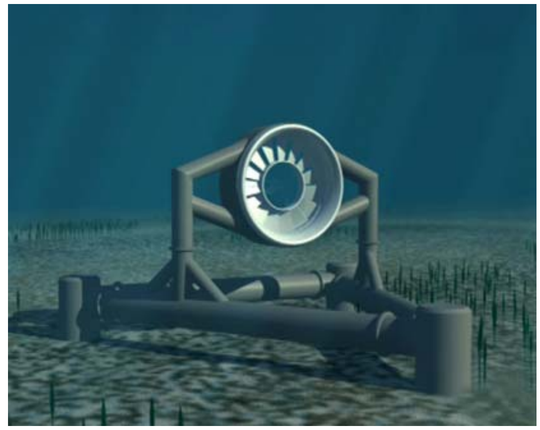


3) Snohomish County Public Utility District No 1 (SnoPUD) Admiralty Inlet Tidal Power Demonstration Project – SnoPUD is located near Seattle, Washington, and is the second largest publicly-owned utility in the Pacific Northwest, and the twelfth largest in the United States in terms of customers served. The PUD has a rapidly growing service load and is required by the Washington State Renewable Portfolio Standard (RPS) to supply 15% of its load from new, renewable energy resources by 2020. As a result of these factors, approximately 140 MW of renewable energy resources needs to be added each year, on average, for the next twelve years. The PUD believes that tidal hydrokinetic energy from the Puget Sound estuary has the potential to contribute significantly toward meeting this challenge, but also believes in-water testing is required to address uncertainties in performance, cost and environmental effects.

The PUD is partnering with OpenHydro of Ireland to conduct the deployment, demonstration and testing of tidal in-stream energy conversion technology in the Admiralty Inlet region of the Puget Sound. The PUD currently envisions a ~1 MW pilot plant consisting of two to three OpenHydro turbines. The PUD envisions plant construction beginning in 2011. This project is currently supported at less than 50%

by the DOE and may need greater Federal funding in the construction phase.





Conclusions

EPRI estimates the recoverable potential to provide electricity from ocean wave and in-stream tidal hydrokinetic resources to be about 10% of today's electric consumption in the U.S. The technology to convert those resources to electricity, albeit in its infancy, is available today for prototype and pilot demonstration testing and evaluation. Initial studies suggest that given sufficient deployment scale, these technologies will be commercially competitive with other forms of renewable power generation. However, significant technical, economic, operational, environmental and regulatory barriers remain to be addressed in order to progress this emerging industry to commercial development.

It is critical for the success of this industry to gain a full understanding of all life cycle-related issues over the coming years to pave the way for larger scale commercial deployments. Such understanding can only be gained in a practical way from the deployment of prototype and pilot demonstration systems in the ocean. Currently, the U.S. marine energy industry is challenged by the lack of proper and standardized infrastructure to deploy and test wave energy conversion devices in the ocean. We are starting to make progress and sustaining this progress with long-term and consistent support is essential for building a globally competitive U.S. industry.

Successful deployment of prototype and pilot demonstration systems will not only address technology and economic related issues, but will also provide confidence to regulators, the general public and investors. Both market push (RD&D) and market pull mechanisms (economic incentives to encourage deployment) will be required to successfully move this technology sector forward and develop the capacity to harness energy from the ocean.

It is very unlikely that any of this early stage development will be funded by the private sector because the risk of failure is too high. When an ocean energy development company can test a prototype scale machine that shows promising performance, reliability and cost, then the private sector investors may be interested. Even at that point, the private sector will not want to assume all of the financial risk and exposure to fully fund the first demonstration projects, or the first commercial projects, so some sort of support for these early commercial projects will be essential to get the industry started.

In retrospect, it is interesting to note that there are currently only two major U.S. companies selling large utility scale wind turbines in the United States, out of about a dozen that attempted to develop wind systems over the past 30 years. On the other hand, there are six major global companies now selling wind turbines in the United States, and several smaller foreign companies. Long term and consistent support through the high risk research and development period and though demonstration is essential for building a globally competitive U.S. MHK industry and commercializing it. It should also be noted that the Europeans already have a 10 year head start on developing MHK technology.

The eventual level of MHK power capacity in the U.S. will be strongly dependent on enabling actions and policies that support the development of the industry.

The establishment of national MHK deployment and timeline goals and the research, development and demonstration pathways or roadmap to success will assist in fully developing this potential. The funding needed to implement the roadmap and achieve the goals will be a significant higher than current levels, but within historical percentages for government agencies and private industry. Given the long technology development and deployment lead times inherent in capital intensive industries like energy, investment and policy decisions cannot be delayed without risk of losing opportunities for technology options that we expect will prove tremendously valuable to our nation in a carbon-constrained future.

Thank You

Roger Bedard
EPRI Ocean Energy Leader
November 29, 2009