OCEAN RENEWABLE ENERGY COALITION
The Marine and Hydrokinetic Energy Trade Association

U.S. Marine and Hydrokinetic Renewable Energy Roadmap

EXECUTIVE SUMMARY

A National Strategy to Support U.S. Energy Security and Create Jobs through the Commercialization of Marine Renewable Energy Technologies

November 2011

Overview

The U.S Marine and Hydrokinetic Renewable Energy Roadmap is a blueprint for the commercialization of technologies that capture and convert clean, sustainable renewable energy from free-flowing waves, tides and currents that have the potential to provide up to ten percent of our nation's electricity. In order to capture the benefit of these resources, the U.S. marine and hydrokinetic (MHK) industry has developed this Roadmap to guide the Federal Government's investments in technology development and needed reforms to the current regulatory framework. MHK technologies present job creation and export opportunities for a global market estimated at more than $750 billion from 2010 through 2050. With strong federal support, developers in the U.S. MHK industry can provide domestic carbon-free electricity and capture a significant portion of the 240 GW projected for installation globally in the coming decades.

The Roadmap describes the issues, challenges and opportunities facing the MHK industry and declares a clear, logical path to the commercialization of technologies that contribute to a clean, sustainable and diverse electric generating capability. It focuses on taking steps to overcome the challenges to widespread deployment and use of MHK technologies. Finally, the Roadmap presents schedules for action on technology research and development along with public policy reforms necessary to achieve the successful commercialization of MHK devices by 2030.

Ocean Renewable Energy Coalition
301.869.3790 · www.oceanrenewable.com

Vision Statement

Our vision for the U.S. MHK industry is to achieve the following goals by 2030:

- A commercially viable U.S. MHK renewable energy industry, supported by a robust domestic supply chain, competing on a level playing field with other energy sources, and serving domestic and international marketplaces; and,
- An operational U.S. MHK renewable energy capacity of at least 15 GW deployed in an economically, environmentally and socially responsible manner.

This vision for an emergent U.S. MHK renewable energy industry is aggressive given how few MHK systems, even prototypes, are deployed worldwide. Nevertheless, the stakeholders based these goals on examples of previous technologies that achieved growth and profitability even more rapidly.

Key Factors to MHK Commercialization

There are eight key areas that the Federal Government and stakeholders must work on together to overcome the barriers to commercialization of the U.S. MHK industry by 2030. These issues must be addressed throughout each phase of the commercialization pathway. The eight key areas are:

1. **Technical Research and Development**
   - Perform fundamental and applied research on MHK technologies.
2. **Policy Issues**
   - Develop a policy framework that supports a stable market and informs and educates policymakers.
3. **Siting and Permitting**
   - Assess high potential marine resources and develop siting and permitting guidelines for development.
4. **Environmental Research**
   - Perform in situ studies of effects and benefits of MHK energy generation technologies and establish methods to avoid, minimize and mitigate.
5. **Market Development**
   - Develop a market expansion needs assessment including jobs, ports, ships, materials, community education, standards and approaches for meeting them.
6. **Economic and Financial Issues**
   - Analyze support mechanisms, technology pathways, performance, cost and deployment and develop approaches to address any barriers.
7. **Grid Integration**
   - Support utility integration studies that assess variability, capacity value, interconnection and approaches to overcoming these barriers including the benefits of predictable MHK generation.
8. **Education and Workforce Training**
   - Develop the science, engineering and technician educational programs needed to support the MHK industry.

Job Creation

The MHK industry has significant potential for job creation in the manufacturing and marine services sectors. We estimate that our goal of 15 GW installed capacity by 2030 would support the creation of nearly **36,000** direct and indirect jobs across the country for fabrication, installation, operations and maintenance of MHK devices.

Federal Government's Role in MHK Development and Commercialization

The Federal Government officially recognized MHK technologies as a source of renewable energy with passage of the Energy Policy Act (EPAct) of 2005. The Energy Independence and Security Act (EISA) of 2007 authorized funding for basic and applied technology research and development for marine renewable technologies and demonstration projects under the Department of Energy's (DOE) Water Power program. The resulting DOE research and development funding has offered opportunities for developers to leverage government investments and raise private capital that supports industry development. DOE's efforts, coupled with those of the Department of Defense (DOD), which has identified its own ambitious renewable energy requirements and funding structures, have supported the nascent MHK industry as it moves toward commercialization. Now is the time to capitalize on these initial federal investments with a sustained commercialization program.

Technology and Technical Information Research and Development Priorities

The Federal Government has a critical role in supporting research and development of MHK technologies. This support is necessary to achieve the commercial strategy and mobilize widespread deployment. Federal research investments should facilitate the commercialization efforts of the MHK industry in three important areas, including, but not limited to, technology and technical information development, national test infrastructure and coordinated resource assessment and characterization of deployment sites.

Public Policy Reforms

Federal public policy reforms are necessary to support the MHK commercialization strategy in three areas, including a reformed regulatory framework for pilot and initial stage projects, adopting project-based Adaptive Management solutions and accelerating the permitting process.

The Pathway to Commercialization

Phase I:	**Demonstration and Pilot Projects (pre-commercial, grid connected)**		
	100 kW	→	5 MW
Phase II:	**Pilot Projects growing into Commercial Project Arrays**		
	5 MW	→	50 MW
Phase III:	**Small Arrays growing into Commercial Utility-Scale Arrays**		
	50 MW	→	100 MW

The Roadmap identifies the issues that will shape commercialization of the MHK industry and explains what factors are common to all types of offshore renewable energy production in the U.S. Further, it offers a phased approach for responsible commercialization of the MHK industry with three critical stages that support increasing project complexity from demonstrations to pilot projects, pilots to small commercial arrays, and commercial arrays to large, utility scale arrays.

1. **Technology Demonstration and Pilot Projects**
   The American MHK industry is at an early stage of development, with only a handful of pilot demonstration projects operating in U.S. waters. The installation of additional demonstration devices in open-water settings is a critical step to allow developers to gather crucial operational data for projecting device performance, improving designs and establishing baseline costs.

Sound and Sea Technology helps to install Columbia Power Technologies' SeaRay wave energy intermediate scale prototype in the Puget Sound in 2011.

2. **Pilot Projects Transitioning to Commercial Arrays**
   The second stage will have technology developers, universities and researchers first installing multiple devices into arrays in energetic locations by 2015. The MHK industry will gain knowledge of complex machine responses to the marine environment and between devices, as well as measurable effects of the devices on the marine environment.

3. **Commercial Arrays Transitioning into Utility-Scale Arrays**
   The final stage requires that devices be made into cost effective, reliable and efficient energy producers with minimal maintenance cycles and negligible impacts on the marine environment. When all of these considerations are met, scaling-up will occur to build profitable commercial ocean renewable energy projects of 100MW or greater in size. Continually advancing the technology development will occur gradually over time, and the U.S. MHK will eventually compete at equal or lower costs with conventional energy sources as well as other renewable energy generation.

Key Conclusions

Capturing the MHK industry lead will require strategies that establish a system of consistent R&D funding, support for MHK test infrastructure and facilities, accelerated decision making in permitting and regulation and a mix of financial incentives that foster the development of a national and international MHK market. However, the most pronounced underlying success factor is the ability to focus resources – commercial, financial, scientific and political – on deploying MHK devices and studying their interactions with the natural environment, increasing technical efficiencies and learning from direct experience. The ability to dedicate and focus resources is the critical path to MHK commercialization.

The Roadmap sets forth ambitious but attainable goals to establish a commercially viable MHK renewable energy industry by 2030 that competes on a level playing field with other energy sources, promotes a robust domestic supply chain and serves both domestic and international markets. Further, if the commercialization path set forth in the Roadmap is adopted, the U.S. is in a favorable position to achieve at least 15 GW of deployed MHK energy by 2030.

It is clear that the U.S. has taken the initiative to recognize and address many of the issues that serve as barriers not only to its competitive position in the international MHK sector, but to the domestic commercialization of the industry as well. It is apparent that U.S. MHK successes, though welcome, underscore the need for better coordination among U.S. state and federal agencies, the scientific and engineering communities and within the industry itself. As such, it is vital for the U.S. to continue to pursue technical R&D, building national testing infrastructure, refining the MHK policy framework to include guidelines for siting, permitting, adaptive management and phased deployment, leveraging existing workforce and manufacturing experience to develop and strengthen the MHK market, enacting economic and financial incentives to spur growth and private investment and lastly, the continuation of educating the public and employing best practices in the development and eventual commercialization of the industry.

Given the wide recognition and acceptance of a sustainable energy future to achieve U.S. energy independence and increased reliability, the MHK industry is confident that the benefits of past and future investments will result in the timely commercialization of a vibrant MHK industry.

About the Ocean Renewable Energy Coalition

The Ocean Renewable Energy Coalition (OREC) is the only national trade association exclusively dedicated to promoting marine and hydrokinetic renewable energy technologies from clean, renewable ocean resources. Founded in April of 2005, the Coalition has grown to over 60 members including technology developers, consultants, law firms, investor-owned utilities, publicly owned utilities, universities, and scientific and engineering firms. 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.

OREC seeks a legislative and regulatory regime in the U.S. that fosters the growth of ocean renewable technologies, their commercial development, and support in the race to capture the rich energy potential of our oceans. 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 of these technologies.

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