

## MODIFICATIONS

All modifications to the Funding Opportunity Announcement are highlighted in **yellow** in the body of the FOA.

Mod. No.	Date	Description of Modifications
0001	6/19/2014	The purpose of this modification is to extend the deadline for responses to this RFI to 6/30/2014 at 5:00pm ET.

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## Marine and Hydrokinetic Device Field Measurements

**DATE:** May 15, 2014

**SUBJECT:** Request for Information (RFI)

**DESCRIPTION:**

The U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy invites input from the public regarding a potential effort to obtain field measurement data on and around large-scale (1:5 or greater) marine and hydrokinetic (MHK) devices, specifically wave energy converters (WECs) or current energy converters (CECs). Comments regarding the availability of devices and pre-permitted sites for such an effort are specifically requested, as well as discussion of the potential benefits of verified and validated open source numerical design tools and publicly accessible field measurement validation datasets.

**BACKGROUND:**

The U.S. Department of Energy's (DOE) Wind and Water Power Technology Office (WWPTO) has a clear role in expediting the development and deployment of innovative MHK devices with credible potential for lowering the levelized cost of energy (LCOE) below the local "hurdle" price at which wave energy converters (WECs) and current (tidal, river, or ocean) energy converters (CECs) can compete with other regional generation sources without subsidies. The WWPTO can do this by helping to eliminate uncertainties, mitigate risks, invest in key technological innovations, and support the private sector in creating a robust U.S. MHK industry.

Currently, a key cost driver in the development of WECs and CECs is the lack of data on actual deployed device performance. The WWPTO seeks to reduce developer cost and time to market by collecting this performance data for the express purpose of verifying and validating advanced open source MHK tools and models. Accurate, predictive design tools will allow developers to decrease costs if they are able to reduce the safety margins that are currently built into designs to account for uncertainties. The availability of open source codes reduces development time and cost, enables software customization, spurs innovation, and creates expertise within the MHK community. Similarly, the availability of validation data sets enhances confidence in existing design tools by increasing transparency of the validation process.

The DOE undertook a similar effort to develop wind power technology in the mid-1980s, coordinating industry developers and National Laboratories in collaborative field tests of large scale prototype and demonstration devices. Data gathered during these tests were used to verify and validate open source numerical design tools, later generations of which include the Fatigue, Aerodynamics, Structures, and Turbulence (FAST) software, currently certified by the Germanischer Lloyd WindEnergie GmbH as suitable for the calculation of onshore wind turbine loads for design and certification (GL Wind Certificate No. ZZ 001A-2005). The development of this certified open source design code has reduced developer costs, compressed development

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timelines, and enhanced investor and insurance provider confidence, accelerating the advancement of the U.S. wind energy industry. This current RFI is intended to inform the development of a similar verification and validation effort in cooperation with the U.S. MHK industry.

The WWPTO envisions a collaborative and comprehensive effort to measure performance, dynamic loads, and ambient effects of the WEC or CEC. For example, a large scale CEC turbine field measurement effort might be designed to acquire high-precision, time-correlated data via Acoustic Doppler Current Profilers (ADCPs), Acoustic Doppler Velocimeters (ADVs), strain gauges, and turbine and generator position sensors (see Figure 1 below). These measurements would be used to characterize the inflow, basic turbine dynamics, energy generation, blade strain, and wake. Validation of the device and any relevant computational modeling tools against these data would illuminate any persisting areas of uncertainty and risk, which could be addressed subsequently in the design cycle and, if non-proprietary, by the greater MHK industry. Multiple such validated devices could, in turn, form the basis of industry-specific standards.

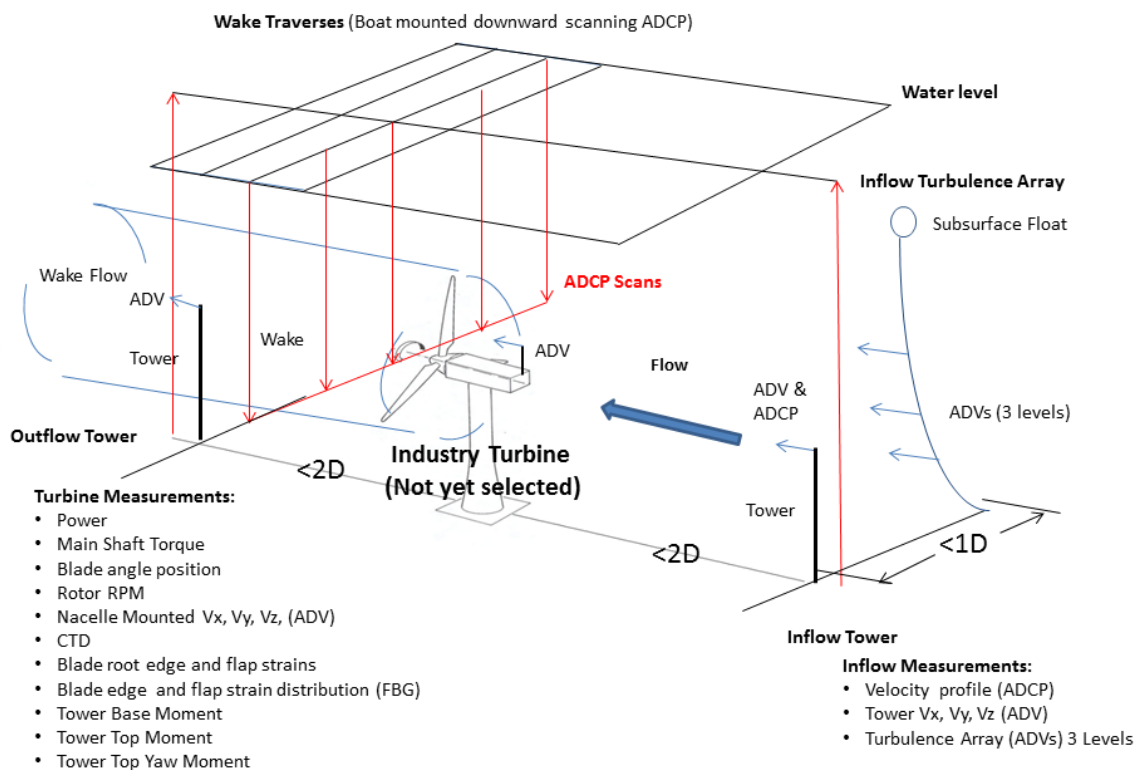


Figure 1. An illustration of a potential field measurement scheme for a large-scale tidal turbine deployment, showing data collection designed to characterize the inflow, basic turbine dynamics, energy generation, blade strain, and wake.

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**PURPOSE:** The purpose of this RFI is to solicit feedback from industry, academia, research laboratories, government agencies, and other marine and hydrokinetic power stakeholders. The information gathered with this RFI will be used to inform strategic planning by the Wind and Water Power Technology Office (WWPTO) to advance the marine and hydrokinetic industry. The WWPTO is specifically interested in collecting and disseminating field measurement data of large-scale (1:5 or greater) devices for the purpose of verifying and validating advanced, open source MHK design tools and models. This is solely a request for information and not a Funding Opportunity Announcement (FOA). EERE is not accepting applications for funding or other opportunities related to this RFI.

**DISCLAIMER AND IMPORTANT NOTES:** This RFI is not a Funding Opportunity Announcement (FOA); therefore, EERE is not accepting applications at this time. EERE may issue a FOA in the future based on or related to the content and responses to this RFI; however, EERE may also elect not to issue a FOA. There is no guarantee that a FOA will be issued as a result of this RFI. Responding to this RFI does not provide any advantage or disadvantage to potential applicants if EERE chooses to issue a FOA regarding the subject matter. If EERE chooses to issue a FOA related to this matter, final details, including the anticipated award size, quantity, and timing of EERE funded awards will be subject to Congressional appropriations and direction.

Any information obtained as a result of this RFI is intended to be used by the Government on a non-attribution basis for planning and strategy development; this RFI does not constitute a formal solicitation for proposals or abstracts. Your response to this notice will be treated as information only. EERE will review and consider all responses in its formulation of program strategies for the identified materials of interest that are the subject of this request. EERE will not provide reimbursement for costs incurred in responding to this RFI. Respondents are advised that EERE is under no obligation to acknowledge receipt of the information received or provide feedback to respondents with respect to any information submitted under this RFI. Responses to this RFI do not bind EERE to any further actions related to this topic.

**PROPRIETARY INFORMATION:** Because information received in response to this RFI may be used to structure future programs and FOAs, and/or otherwise be made available to the public, **respondents are strongly advised NOT to include any information in their responses that might be considered business sensitive, proprietary, or otherwise confidential.** If, however, a respondent chooses to submit business sensitive, proprietary, or otherwise confidential information, it must be clearly and conspicuously marked as such in the response.

Responses containing confidential, proprietary, or privileged information must be conspicuously marked as described below. Failure to comply with these marking requirements may result in the disclosure of the unmarked information under the Freedom of Information Act or otherwise. The U.S. Federal Government is not liable for the disclosure or use of unmarked information, and may use or disclose such information for any purpose.

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If your response contains confidential, proprietary, or privileged information, you must include a cover sheet marked as follows identifying the specific pages containing confidential, proprietary, or privileged information:

**Notice of Restriction on Disclosure and Use of Data:**

Pages [list applicable pages] of this response may contain confidential, proprietary, or privileged information that is exempt from public disclosure. Such information shall be used or disclosed only for the purposes described in this RFI, DE-FOA-0001118. The Government may use or disclose any information that is not appropriately marked or otherwise restricted, regardless of source.

In addition, (1) the header and footer of every page that contains confidential, proprietary, or privileged information must be marked as follows: “Contains Confidential, Proprietary, or Privileged Information Exempt from Public Disclosure” and (2) every line and paragraph containing proprietary, privileged, or trade secret information must be clearly marked with double brackets or highlighting.

**EVALUATION AND ADMINISTRATION BY FEDERAL AND NON-FEDERAL**

**PERSONNEL:** Federal employees are subject to the non-disclosure requirements of a criminal statute, the Trade Secrets Act, 18 USC 1905. The Government may seek the advice of qualified non-Federal personnel. The Government may also use non-Federal personnel to conduct routine, nondiscretionary administrative activities. The respondents, by submitting their response, consent to EERE providing their response to non-Federal parties. Non-Federal parties given access to responses must be subject to an appropriate obligation of confidentiality prior to being given the access. Submissions may be reviewed by support contractors and private consultants.

**REQUEST FOR INFORMATION CATEGORIES AND QUESTIONS:**

The WWPTO requests information in three broad categories: (1) questions regarding data and design tool gaps and deployment plans; (2) WEC intellectual property considerations; and (3) CEC intellectual property considerations. Respondents are encouraged to complete category (1) and either category (2) or category (3). The information gathered from this RFI will be used to inform strategic planning by the WWPTO to advance the MHK industry.

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**CATEGORY 1: Data and Design Tool Gaps and Deployments Plans**

- Regarding the potential availability of a field measurement dataset and/or verified and validated open-source design tools or models:
  - What numerical design tools or models does your company currently utilize? Is this software open source, in house, or commercial?
  - What critical gaps in field measurement data would your company seek to fill (e.g. incident wave power spectrum, inflow turbulence intensity, strain distribution)? How could public access to a device field measurement validation dataset directly address these gaps?
  - What critical gaps in your current software capabilities would your company seek to fill (e.g. snap loads, stall, system nonlinearities)? How could access to open source verified and validated design tools or models directly address these gaps?
  
- Regarding your company's large-scale (1:5 or greater) MHK device:
  - What type (e.g. 3-bladed axial flow turbine, point absorber w/ single point mooring) and scale/dimensions is the device?
  - How might field measurements of your device advance its technical readiness and commercial viability?
  - What is the soonest your company could be prepared to demonstrate or deploy? What significant challenges remain to be addressed prior to demonstration or deployment?
  - Where might your company demonstrate or deploy? Is the site permitted? What advantages and challenges are anticipated in demonstrating or deploying at that site?
  
- Regarding participation in a collaborative effort coordinated by the DOE to collect field measurements on and around a full-scale device:
  - What resources (e.g. expertise, vessels, and instruments) might you be able to make available to aid in a field measurement effort?
  - What particular capabilities would you value from the DOE National Laboratories to collect high fidelity data?
  - Would you be willing to embed sensors and instruments into your company's device? What concerns do you have in instrumenting the device and the site? What modifications would be possible to accommodate sensors?
  - Where intellectual property issues are a significant barrier to publicly disseminating data gathered on and around your company's device, would your company be willing to operate your device using non-proprietary componentry (e.g. components built to [Reference Model](#) specifications)?

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**CATEGORY 2: Intellectual Property - Wave Energy Converters (WEC)**

Please indicate in the following table what device and field measurement data you would be willing to release to the public. Please also indicate which data you would not be willing to release to the public, as well as those that you would release with some restrictions. For data that you would release with restrictions, please briefly describe those restrictions (e.g., non-dimensionalized data).

TEST DATA	DATA NEEDS and RATIONALE	Public Release	Public Release w/ Restrictions	Proprietary
<b>Comprehensive Test Log</b>	Describing all measurements and the purpose of different measurements			
<b>Device Geometry &amp; Structural Data</b>				
<b>Detailed Device Drawings</b>	Need the device dimensions and shape to predict performance			
<b>Device structural and mass properties</b>	Need to match natural frequencies			
<b>Mooring configuration</b>	Need to match natural frequencies			
<b>Mooring structural properties</b>	Need to match natural frequencies			
<b>Generator torque, speed and efficiency curves</b>	Need to closely match the rotor drive converter natural frequency and have an estimate for any electrical system damping in the rotation direction			
<b>PTO torque, speed and efficiency curves</b>	Need to match natural frequencies			
<b>Device Measurements</b>	Synchronized with inflow measurements			
<b>PTO state/position</b>	Needed for separation of quasi-steady and PTO-induced loads			
<b>Generator rotation rate</b>	To determine power and efficiency			
<b>Generator shaft torque</b>	To determine mechanical rotor power			
<b>Generator power output</b>	To determine device power performance			
<b>Mooring tension</b>	Needed to resolve loads			
<b>Device motion</b>	To validate device dynamics			
<b>Video feed of device platform</b>	For qualitative understanding of device motion and overtopping			
<b>Incoming Wave-field Measurements</b>	Synchronized with device measurements			
<b>Wave amplitude and period</b>	To estimate device efficiency			
<b>Surface mean-velocity</b>	To separate mean-velocity induced motion from wave-induced motion			
<b>Other</b>				

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**CATEGORY 3: Intellectual Property - Current Energy Converters (CEC)**

Please indicate in the following table what device and field measurement data you would be willing to release to the public. Please also indicate which data you would not be willing to release to the public, as well as those that you would release with some restrictions. For data that you would release with restrictions, please briefly describe those restrictions (e.g., non-dimensionalized data).

TEST DATA	DATA NEEDS and RATIONALE	Public Release	Public Release w/ Restrictions	Proprietary
<b>Comprehensive Test Log</b>	Describing all measurements and the purpose of different measurements			
<b>Turbine Geometry &amp; Structural Data</b>				
<b>Turbine Drawings</b>	Need the turbine overall dimension & properties			
<b>Blade structural and mass properties</b>	Need to match blade natural frequencies			
<b>Blade shape</b>	Detail of blade shape, plan-form, twist and taper			
<b>Airfoil data</b>	Data through stall is highly desirable			
<b>Tower mass and elastic properties</b>	Need to match the actual tower natural frequency			
<b>Power Converter torque, speed and efficiency curves</b>	Need to closely match the rotor drive converter natural frequency and have an estimate for any electrical system damping in the rotation direction			
<b>Device Measurements</b>	Synchronized with inflow measurements			
<b>Rotor position (1 degree resolution)</b>	Needed for separation of quasi-steady and turbulence loads – treated as a pseudo time			
<b>Rotor rotation rate</b>	To determine power and efficiency			
<b>Shaft torque</b>	To determine mechanical rotor power			
<b>Blade strain along the length of the blade</b>	Needed to resolve loading along the blade span using strain sensors			
<b>Tower strain at base</b>	To determine bending at tower base			
<b>Turbine natural frequencies</b>	Need the first two system frequencies and the blade frequencies for code validation			
<b>Inflow Measurements</b>	Synchronized with device measurements.			
<b>ADCP velocity profiles</b>	To measure the velocity shear across the rotor disk.			
<b>ADV nacelle turbulence measurement at turbine</b>	Near-hub turbulence measurements			
<b>ADV inflow turbulence mooring measurements</b>	To correlate them with turbine response			
<b>Wake Measurements</b>	Time averaged wake velocities and 3D distances from the rotor centerline from approximately 2-15 diameters behind the turbine			
<b>Other</b>				

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**REQUEST FOR INFORMATION RESPONSE GUIDELINES:** Responses to this RFI must be submitted electronically to [1118RFIMHK@go.doe.gov](mailto:1118RFIMHK@go.doe.gov) no later than 5:00pm (EDT) on June 30, 2014. Responses must be provided as a Microsoft Word (.docx) attachment to the email, of no more than 5 pages in length, 12 point font, 1 inch margins. Only electronic responses will be accepted.

Please identify your answers by responding to a specific question or topic if possible. Respondents may answer as many or as few questions as they wish.

EERE will not respond to individual submissions or publish publicly a compendium of responses. A response to this RFI will not be viewed as a binding commitment to develop or pursue the project or ideas discussed.

Respondents are requested to provide the following information at the start of their response to this RFI:

- Company / institution name;
- Company / institution contact;
- Contact's address, phone number, and e-mail address.

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