

THE VALUE OF MARINE RENEWABLE ENERGY DATA SHARING AND PRODUCTS OUTREACH

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I. KEYWORDS

Data sharing, data repository, community, marine renewable energy.

II. OVERVIEW

The Marine Renewable Energy (MRE) industry is at a pivotal time in its early stage of development where the commercial viability of emerging technologies hinges largely on the ability of the community of MRE developers, researchers, academics, stakeholders, labs, funding agencies and regulators to work together to share knowledge, experience, and lessons learned towards solving common problems and accelerating technology development and acceptance. While there is an abundance of information available online, it is located on many disparate sites and repositories that make discovery difficult. The US Department of Energy (US DOE) Water Power Technologies Office (WPTO) is addressing the challenge of storing, curating, and accessing MRE information by sponsoring development of MRE databases and information portals such as Tethys, OpenEI, MHK Data Repository (MHKDR), and the MHK Instrumentation Database. These sites host a wealth of knowledge that includes scientific papers, news articles, reports, links to databases and tools, and information that encourages stakeholder engagement, but they are only a step towards facilitating global discovery and use.

The US DOE recently sponsored the MHK Data Products and User Community Development (DPUCD) project which is a joint effort between the National Renewable Energy Laboratory (NREL), Pacific Northwest National Laboratory (PNNL) and Sandia National Laboratories (Sandia) that aims to:

- 1) engage the international MRE community to develop an understanding of the online tool and data needs;
- 2) improve existing databases and portals to better meet these needs; and
- 3) coordinate efforts with the international community to ensure consistency and collaboration in development of online repositories and tools.

III. NEEDS

The project reached out to the international MRE community to understand the needs for online information infrastructure and data products, define the gaps in the existing online infrastructure and content, and recommend solution pathways. To start this work, two workshops were held to engage the international community. The first workshop was co-located with International Marine Renewable Energy Conferences/Marine Energy Technology Symposium (IMREC/METS) in Washington D.C. on May 3, 2017. The second workshop was co-located with the European Wave and tidal Energy Conference (EWTEC) in Cork, Ireland on August 29th, 2017. The team analysed and compiled these needs into six theme areas Figure 1:

- Outreach and Communication: online information sources where the public can learn about MRE technologies, their impacts and challenges. There is also a need to for a site where the community can learn about current events and read the latest MRE-related news.
- Discoverability and Accessibility: search tools and systems with comprehensive metadata the enable MRE reports, data and other information to be quickly identified and downloaded.

- **Data Integrity:** consensus methods of data quality assurance that enable a high-level of confidence in subsequent use and curation activities that review data, information and metadata for accuracy, and adherence to accepted practices. This should also include archiving of older information, so it can be retrieved as needed.
- **Tools and Codes:** opensource tools and data products, such as data processing codes, simulations, and GIS tools that can be developed and advanced by the community to benefit the community.
- **Sharing and Security:** online information repositories that allow sharing of reports, code and other information with levels of security appropriate to protect confidential while sharing within specified groups. In addition, there needs to be capabilities to share information, experience, and knowledge so that the community can leverage and build upon past projects.
- **Best Practices and Standards:** consensus standards on meta data, units, file formats, and file types that will allow information sharing between projects and among countries.



FIGURE 1. MAJOR THEMES FOR ONLINE INFORMATION NEEDS AS EXPRESSED BY THE MRE COMMUNITY

IV. PRIMRE

Based on the six thematic areas identified in the outreach efforts of the DPUCD project, a draft vision was developed for an online information system the authors feel will have tangible benefit to the MRE community - PRIMRE - *Portal and Repository for Information on Marine Renewable Energy*.

PRIMRE seeks to provide broad access to engineering, resource characterization, and environmental effects information on marine renewable energy projects to facilitate the commercial development of the MRE industry. The goals of PRIMRE are to:

1. Establish an information and data portal. Establish a portal to access a consolidated set of data repositories, knowledge bases, and resource atlases that provide access to information needed to support testing, modelling, project siting, and permitting of MRE devices and arrays internationally.
2. Support access to online tools. Support development of and access to tools for data input, quality control, data discovery, analysis, and reporting of MRE testing data.
3. Provide context for receiving MRE data and information. Establish the context for receiving all MRE data through tagging, annotation, QA/QC assessments, and reporting templates.
4. Facilitate connections among data, MRE project needs, and research studies. Act as an honest broker for connecting existing databases and datasets to the MRE projects that can benefit from the information, and to researchers and other stakeholders in support of the MRE industry.

PRIMRE is envisioned to be divided into four functional areas: 1) an information portal, 2) papers and report discovery tools, 3) databases and repositories, and 4) tools and code repositories.

MHK PRIMRE			
Information Portal	Papers, Reports, other Media	Databases	Tools and Code Repositories
<ul style="list-style-type: none"> - Current News Links - Event Calendar - Community/Forum 	<ul style="list-style-type: none"> - Tethys: Environ - Tethys: Engineering - Tethys: Data - Guidance & Standards 	<ul style="list-style-type: none"> - MHK Data Repository - MHK Instrument Database - MHK Technology Resources Database - MHK Technology Development and Testing Database - LCOE Database 	<ul style="list-style-type: none"> - WEC-SIM - MHK Data - MHK LCOE Estimator - MHK Atlas - MHK Energy Prospector

FIGURE 2. THE COMPONENTS OF PRIMRE

Information Portal: Using the OpenEI framework, a front-end information entry point would be developed for users to quickly access information. Users would be able to learn about MRE, including the history, the resource potential, environmental impacts,

technologies, and challenges. There will also be a calendar of events where the community can go and quickly see what is happening around the globe. Through PRIMRE's interface, users would be able to quickly link to US DOE (and other) data repositories and knowledge bases, access open-source tools, and find environmental and engineering/technology reports. Ultimately, the increased access to information, data, and tools should help accelerate technology development and acceptance, as well as to reduce costs.

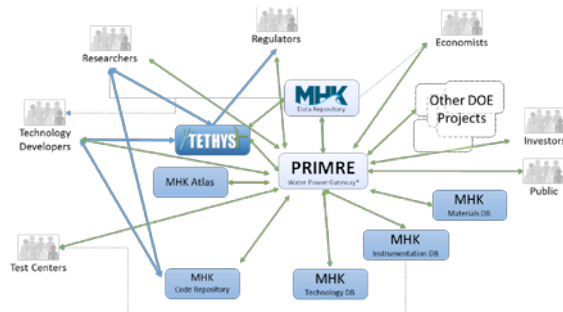


FIGURE 3. EXAMPLE OF THE PRIMRE ENTRY POINT, ORGANIZED TO ALLOW COMMUNITIES OF USERS TO QUICKLY DISCOVER INFORMATION THEY NEED

Papers, Reports, and Data Discovery Tools: PNNL has created the *Tethys* online knowledge management system to facilitate the exchange of information and data on the environmental effects of marine renewable and wind energy technologies and to serve as a commons for marine renewable and wind energy environmental practitioners. Tethys is globally used and recognized as a collaborative research space for the exchange of technical information. It includes a knowledge base that draws together metadata, supporting scientific papers, reports, videos, and other material to provide a current state of knowledge of environmental effects. The extensive metadata and active curation allows users to quickly and confidently locate reports that meet their needs. Under PRIMRE, *Tethys* would be expanded to include two new areas: 1) engineering and 2) datasets. Tethys Engineering would be identical in form and function to Tethys environmental, but would focus on the exchange of information on engineer aspects of MRE technologies. *Tethys* datasets would consist of a search engine to would compile summary data from both engineering and environmental data sets, allowing users to quickly search by key variables to locate data sets and specific data files that meet their needs. PRIMRE would also include sections that overview the standards development effort and international collaborations, such as those through IEA-OES.

Databases: Through prior funded DOE efforts, several databases have been developed that contain a diverse set of information. These databases include the MHK Data Repository, the MHK Instrumentation

Database, the MHK Technology Resources Database, and the Marine and the MHK Technology Development and Testing Database. Through outreach efforts, members of the MHK community indicated that they would also benefit from an LCOE database that would compile information needed to perform a detailed LCOE analysis (e.g. vessel rates by geographic location, wholesale electricity rates by region and time, manufacturing costs, etc.). The outreach effort has also identified many improvements that are needed to increase the functionality and usefulness of the existing databases, such as updating information, so it reflects the current state-of-the art and improves discovery capabilities – part of which would be accomplished through the additions to *Tethys*.

Tools and Code Repositories: The US DOE has also invested in several online tools to help the MHK community in several areas. These include the MHK atlas which helps the community obtain resource information via GIS interface. US DOE has also developed WEC-SIM which is an open-source wave energy converter simulation tool and other tools. Many of these tools, such as Hydro-TurbSim (PyTurbSim) reside on different servers and can be difficult to locate if the user does not know of their existence. The outreach effort has also identified several more tools that would benefit the community. One such tool is the MHK LCOE estimator which could be an online tool that walks users through the development of an LCOE model, much like tax software does for federal income tax filings. Another future tool is an MHK energy prospector which would be GIS-based to develop annual energy estimates for technologies based on their power matrix/curves. PRIMRE would provide a central site to learn about and link to the various tools.

PRIMRE is also envisioned to provide a framework for users to find online open-source data processing and analysis codes. When codes are not available online, PRIMRE could also have a code repository for software that fill these gaps.

Ideally, PRIMRE will be open to the international community to develop, populate and curate. Through developing this framework, we hope the information portal would be useful to the global MRE community.

To ensure that PRIMRE would meet the continuously evolving needs of the MRE community, PRIMRE will undergo periodic reviews and revisions to support new content and functionality. Users would be asked to provide structured feedback on the data portal content.

V. EXPECTED IMPACTS

1. Centralized collection and dissemination point for information - By establishing PRIMRE, a key collection and dissemination point will be created that will allow the MRE industry, researchers, regulators, and other stakeholders to access a common set of data, information, and knowledge products in the US, and internationally.
2. Access to online tools - Through use of PRIMRE and associated online tools, the MRE industry and other stakeholders will have access to objective analysis of existing data, the opportunity to bring together their own emerging data, and to uniformly move forward the understanding of robust design, testing, permitting, and operating processes in support of the MRE industry.
3. Access to existing knowledge – PRIMRE will provide easy access to scientific literature, reports, and other media on the state of development of MRE devices, resource characterization, testing results, installation and maintenance procedures, and environmental risks, through tagging, and annotation, for environmental and engineering information.
4. Broker and encourage use of existing data resources – PRIMRE will ensure that datasets, tools, and links are accessible and well-known to the MRE community and will encourage their use and augmentation.

vision so it satisfies online information needs while leveraging existing online tools and infrastructure. Our hope is that an international collaborative with a common framework can be established. Presently, the authors are developing the information portal and expanded Tethys capabilities through support from the US DOE WPTO.

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PRIMRE Component	Community Data Needs	Outreach & Communication	Tools & Codes	Discoverability	Accessibility & Security	Data Integrity	Best Practices & Standards
OpenEI: Water Power Portal		X		X	X		
Current Events & News		X		X			
Tethys: Environmental, Engineering, Data		X		X	X	X	
MHK Data Repository			X	X	X	X	
MHK Instrument Database		X		X	X	X	
GIS Tools (MHK Atlas)			X		X	X	
MHK Energy Prospector			X		X	X	
Code Repositories			X	X	X	X	X
MHK Data Search Tool				X	X		
Best Practices & Standards		X	X		X	X	X
DOE Technology Databases		X		X	X	X	
LCOE Database/Estimator			X		X	X	

FIGURE 4. COMPONENTS OF PRIMRE MAPPED TO THE SIX THEMATIC NEEDS EXPRESSED BY THE MHK COMMUNITY

VI. FUTURE WORK

PRIMRE is a draft vision and the authors seek further input from the MRE community to refine the