WPTO R&D Deep Dive Webinar Series

Contributing Data and Information to PRIMRE

Speakers
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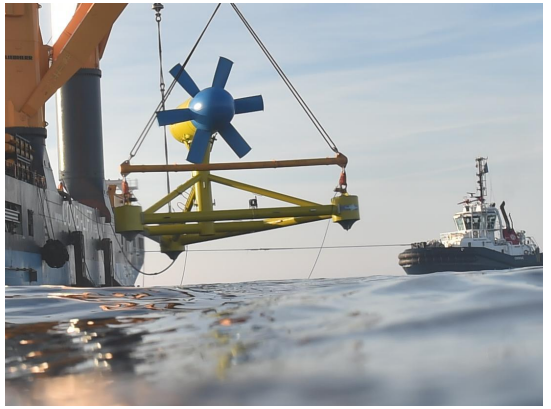
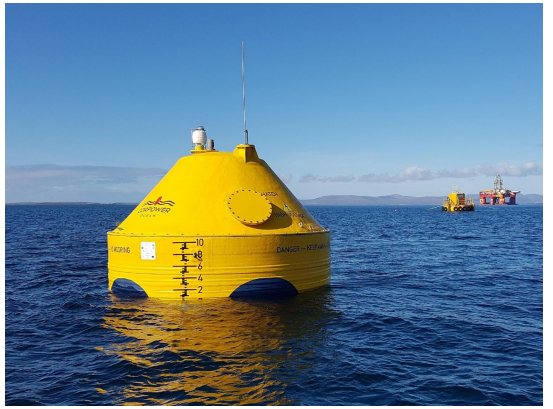
Wednesday, July 28, 2021

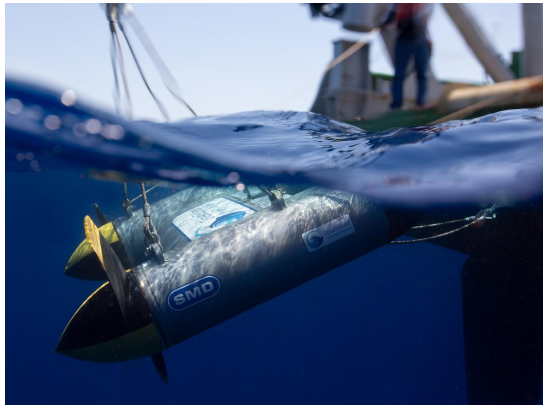
U.S. DEPARTMENT OF ENERGY

Agenda

- The need for PRIMRE
- Introduction to PRIMRE
- PRIMRE Knowledge Hubs
- PRIMRE Aggregate Search
- Contributing to the Knowledge Hubs
- Contributing to PRIMRE
- Signature Projects
- Next Steps for PRIMRE
- Q&A







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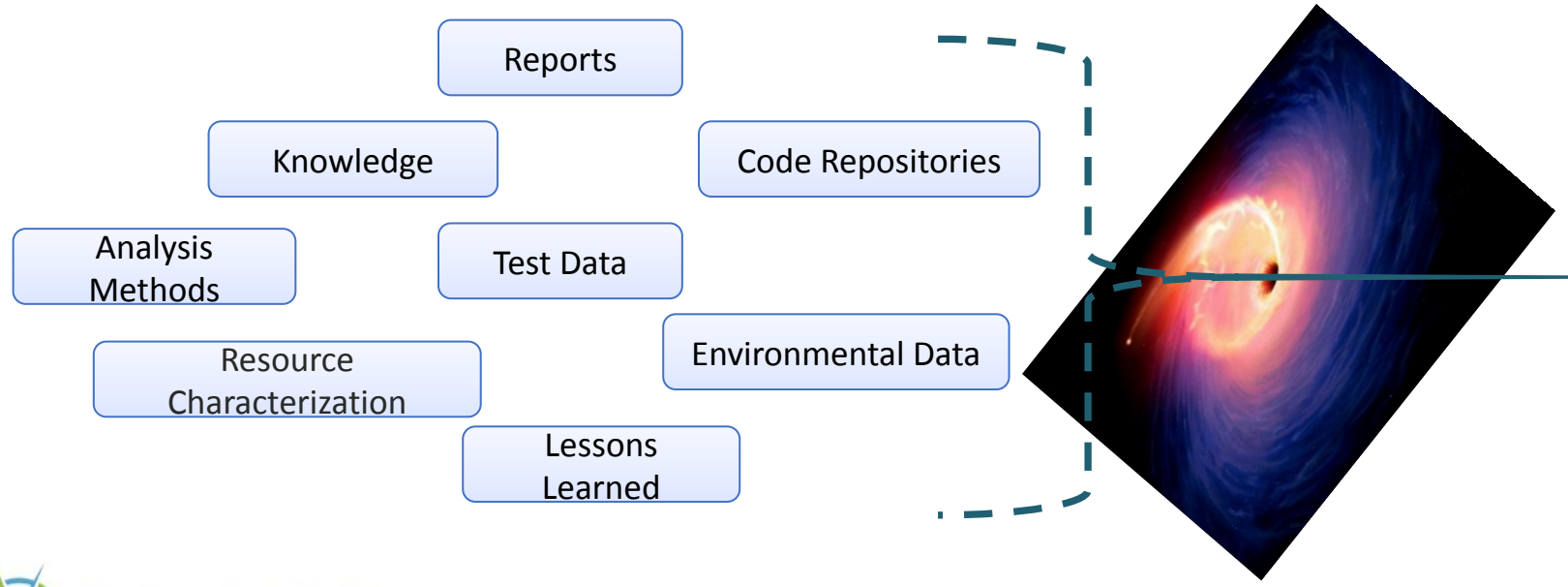
Availability of MRE Knowledge

Data and information are:

- often not made public;
- stored in many locations and in diverse formats;
- and often not catalogued, described, accessible, or discoverable.



PRIMRE was developed to overcome data and information barriers to technology, research, design, and testing in support of the MRE community.

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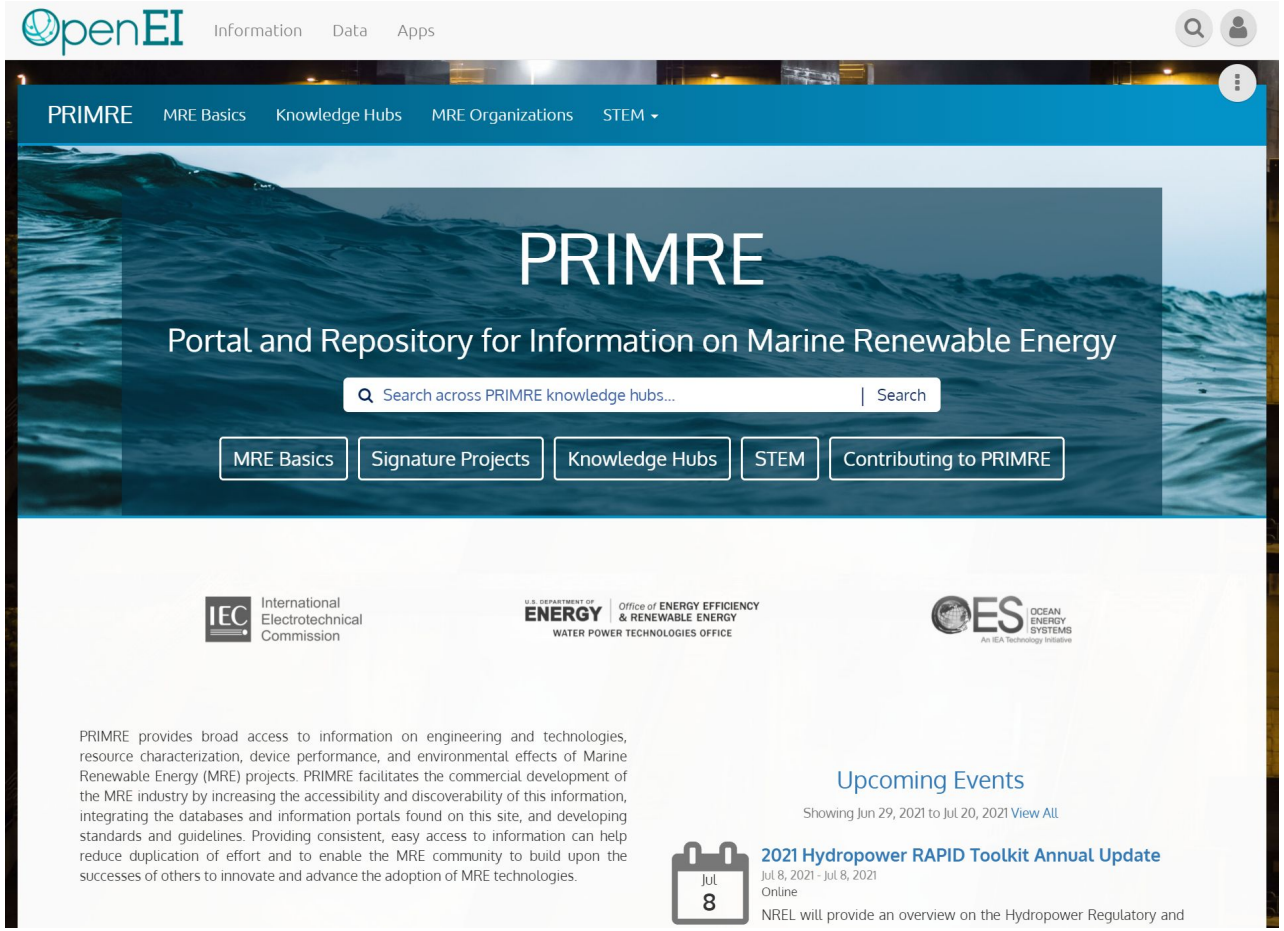
Introduction to PRIMRE

Broad access to data and information on MRE

- Engineering and technologies
- Resource characterization
- Device performance
- Environmental effects

Features

- MRE Basics
- STEM Resources
- Knowledge Hubs
- Aggregate Search



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PRIMRE Knowledge Hubs

Marine and Hydrokinetic Data Repository (MHKDR) hosts data collected by WPTO funded R&D, including device testing data, resource characterization data, etc.

Tethys hosts over 6,700 documents on the environmental effects of wind and MRE development and supports Ocean Energy Systems' Environmental initiative.

Tethys Engineering hosts over 4,800 documents on the engineering and technical aspects of MRE development, as well as a library of MRE photos for third-party use.

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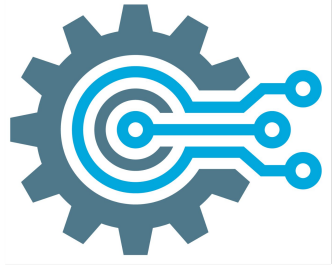
PRIMRE Knowledge Hubs



[Marine Energy Projects Database] contains information on MRE devices and companies active in the MRE field, and traces the development of projects around the world.

Telesto

[Telesto] is a collection of information and guidance for testing, measurement, and data analysis for MRE research, development, and demonstration.

[MRE Software] is a collection of software relevant to MRE development, and is made up of the [MRE Code Hub] and [PRIMRE Code Catalog].

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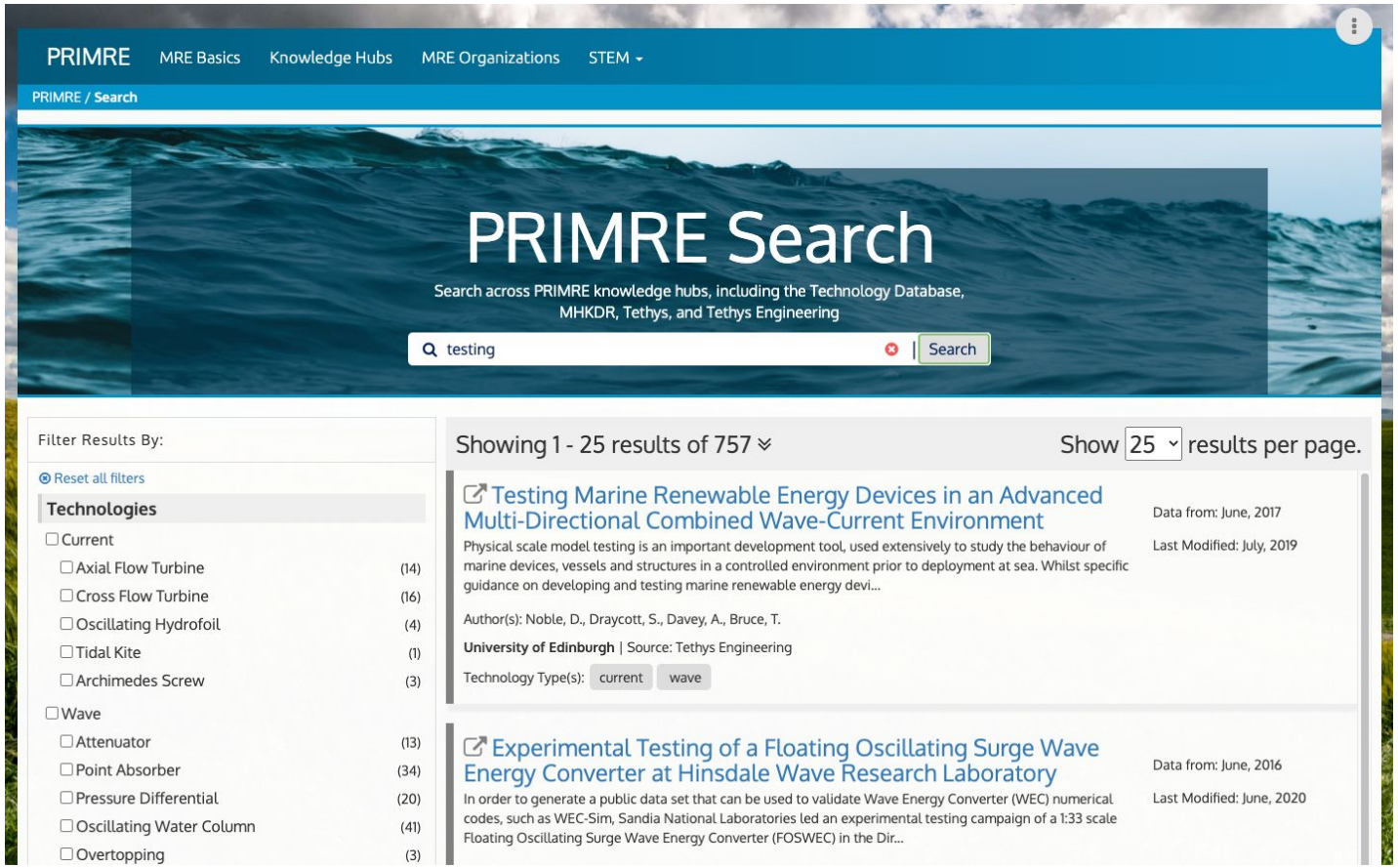
PRIMRE Aggregate Search

- Enables users to find data and information from different Knowledge Hubs simultaneously using PRIMRE as a single entry-point
- Currently operational for:
  - *Tethys*
  - *Tethys Engineering*
  - *MHKDR*
  - *Marine Energy Projects Database*
  - *Telesto*



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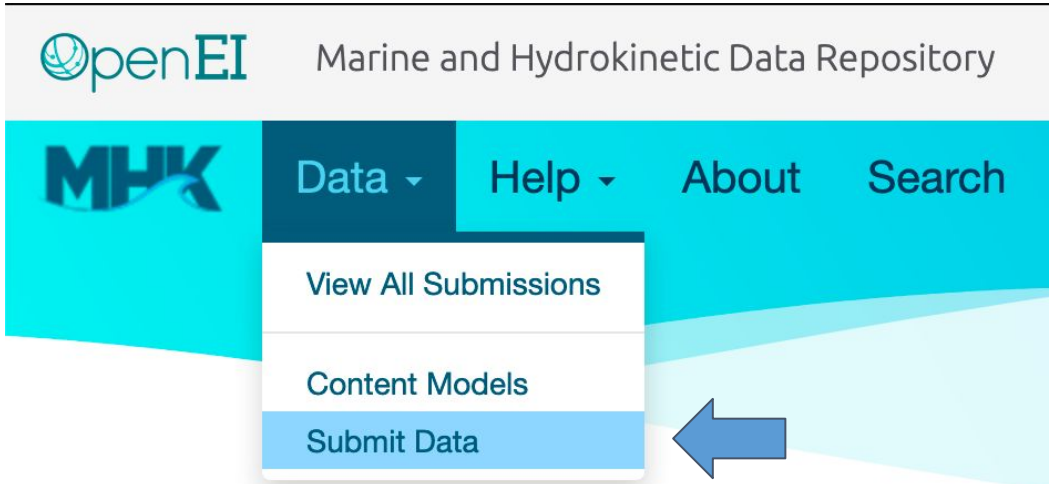
Contributing to MHK Data Repository

What should I contribute?

- Data (e.g., raw data, maps, photos, reports, models, schematics, testing, performance, resource data)
  - All data generated from projects funded by the **DOE Water Power Technologies Office** related to marine energy

How should I contribute?

- https://mhkdr.openei.org/submit



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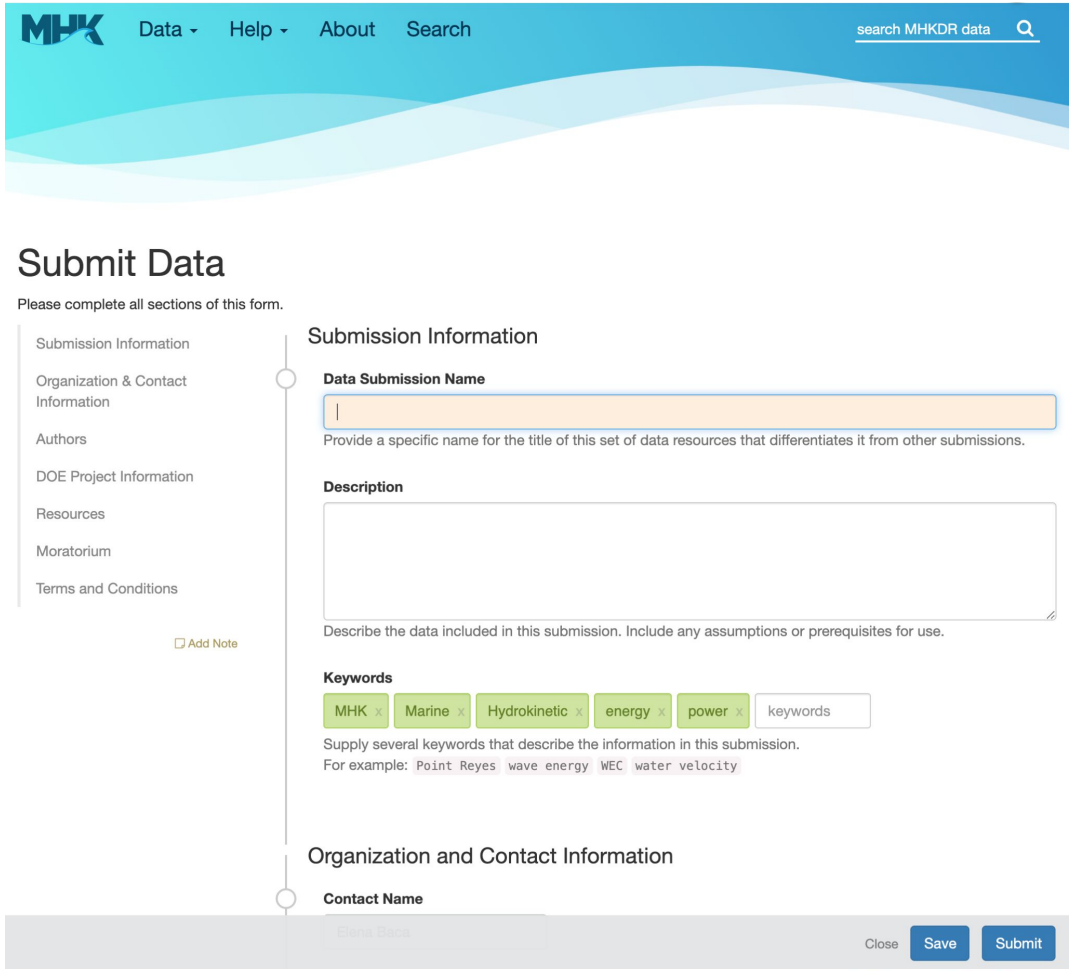
Contributing to MHK Data Repository

- Complete the data submission metadata form
- No limit to file size or number of files
- **Save** as often as you like and return later to complete the submission
- **Submit** when it's all done.
- Currently home to over 2,000 resources and 15 TB of data.



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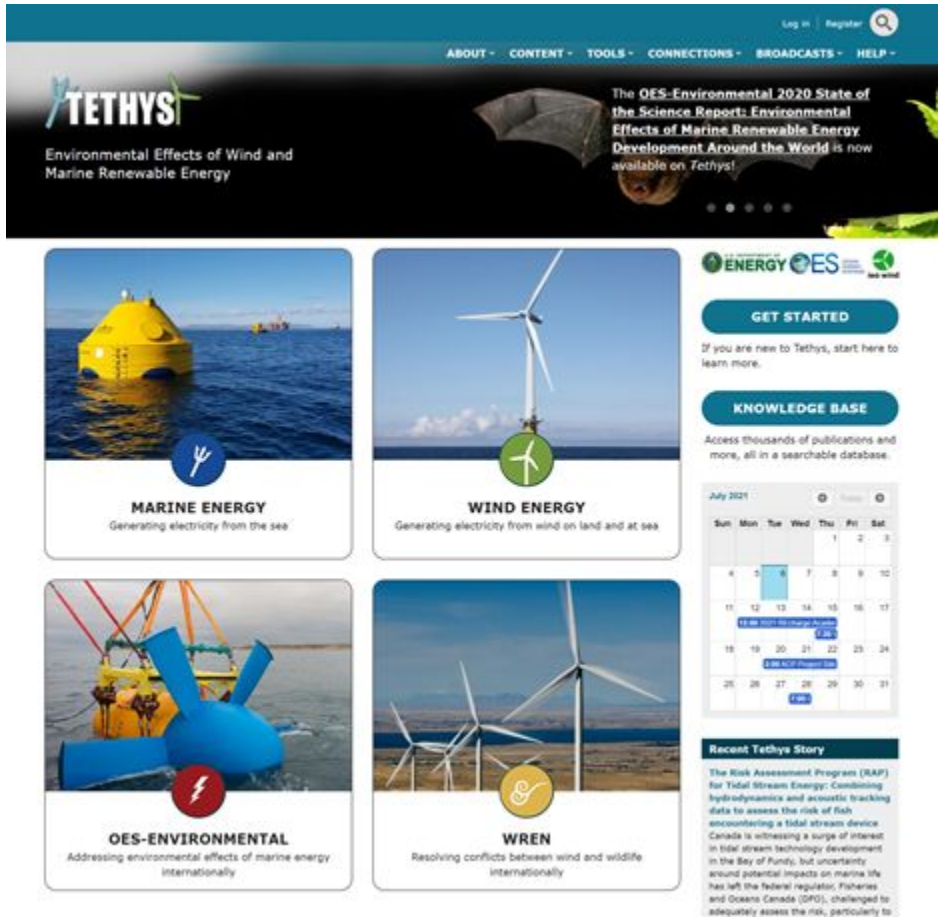
Contributing to Tethys

What should I contribute?

- Documents (e.g., journal articles, conference papers, reports, theses)
  - Relevant to **environmental effects** of wind and/or marine energy
  - Any language (must have an English title and abstract)



How should I contribute?

Email
tethys@pnnl.gov

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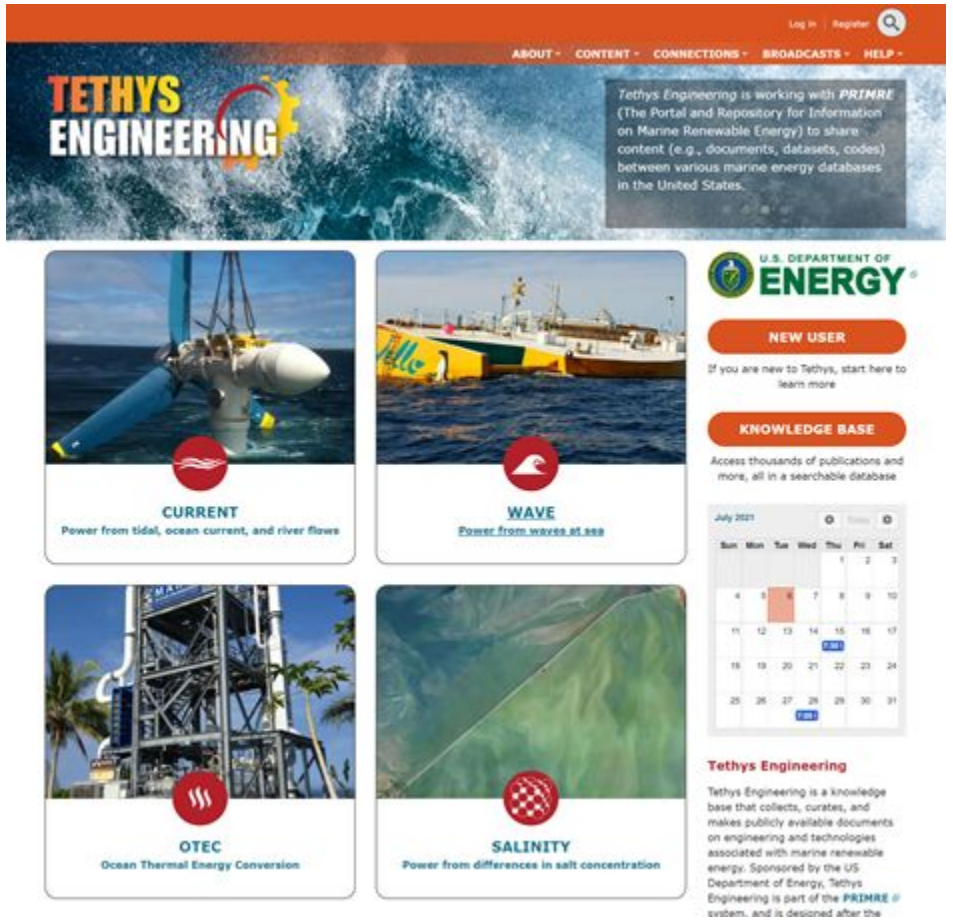
Contributing to Tethys Engineering

What should I contribute?

- Documents (e.g., journal articles, conference papers, reports, theses)
  - Relevant to **engineering and technical aspects** of marine energy
  - Any language (must have an English title and abstract)

How should I contribute?

Email
tethys@pnnl.gov



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Contributing to Tethys & Tethys Eng.

Other Ways to Contribute

- Register for an account and link your author profile.
- Update your organization's description.
- Submit photos to the Photo Library.
- Submit an event for the Events Calendar.
- Submit content for the Tethys Blast & Tethys Engineering Blast.

Email
tethys@pnnl.gov

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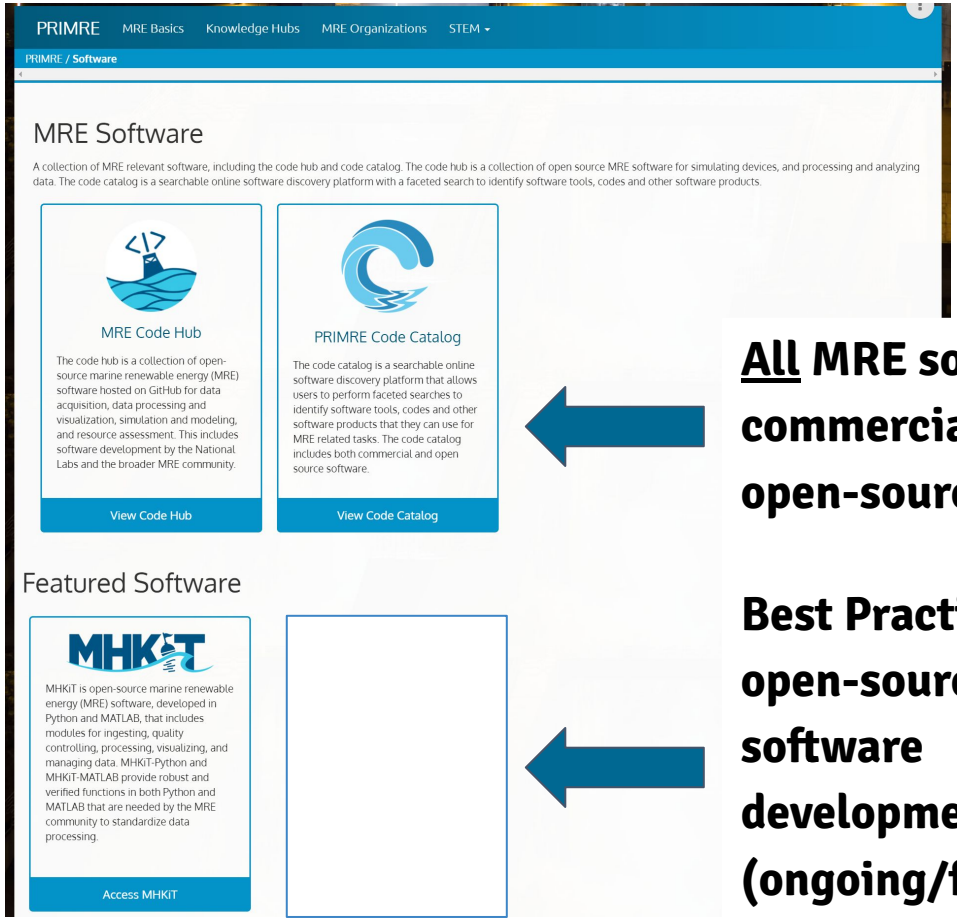
Contributing to MRE Software

MRE Software is a collection of software relevant to MRE development, including the MRE Code Hub and the PRIMRE Code Catalog.

Open-source MRE software (on GitHub)

Highlights newly released software



All MRE software, commercial and open-source

Best Practices for open-source software development (ongoing/future work)

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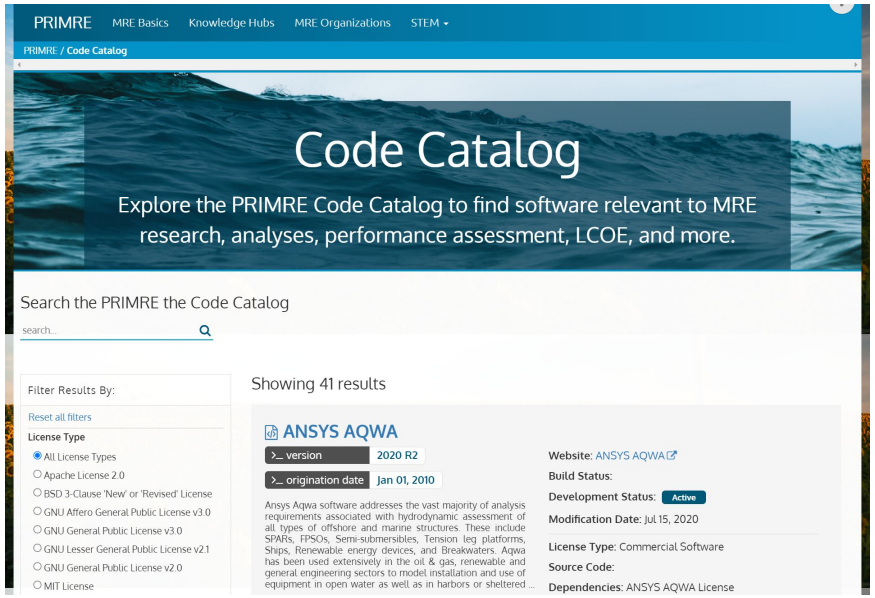
Contributing to MRE Software

PRIMRE Code Catalog

- Searchable online software discovery platform with search facets for all MRE relevant software



MRE Code Hub

- Repository for open-source MRE software, includes a landing page with search functionality

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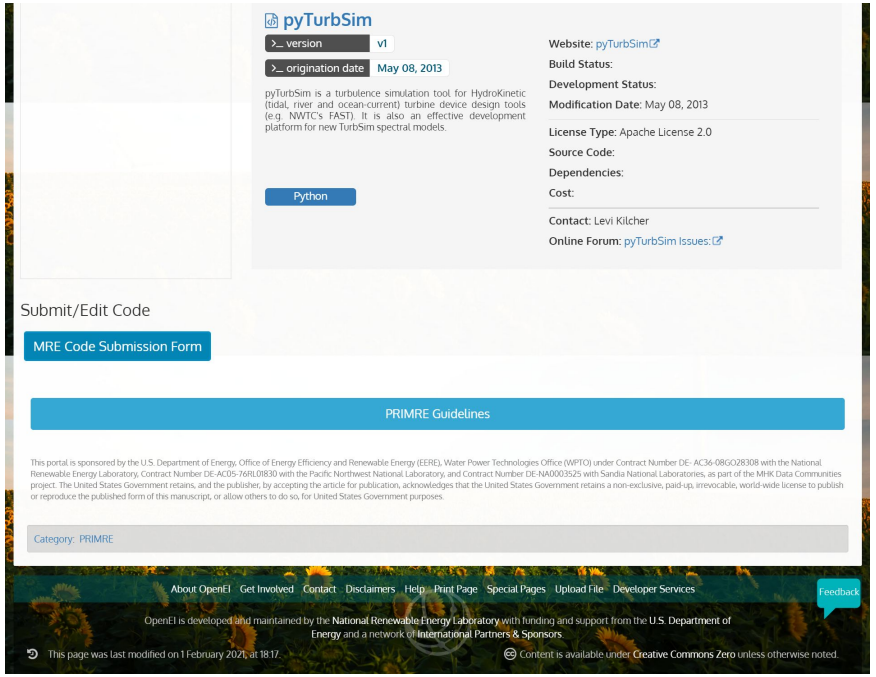
PRIMRE Code Catalog Submission

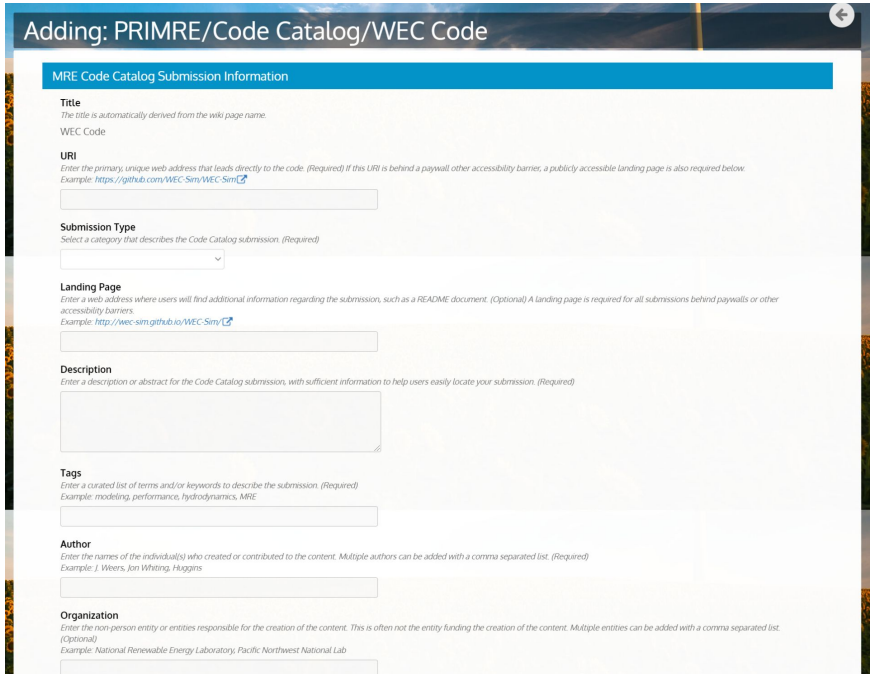
Launch MRE Code Submission Form

- Click MRE Code Submission Form button at the bottom of Code Catalog list



Submission Form

- Mix of required and optional metadata/properties for software



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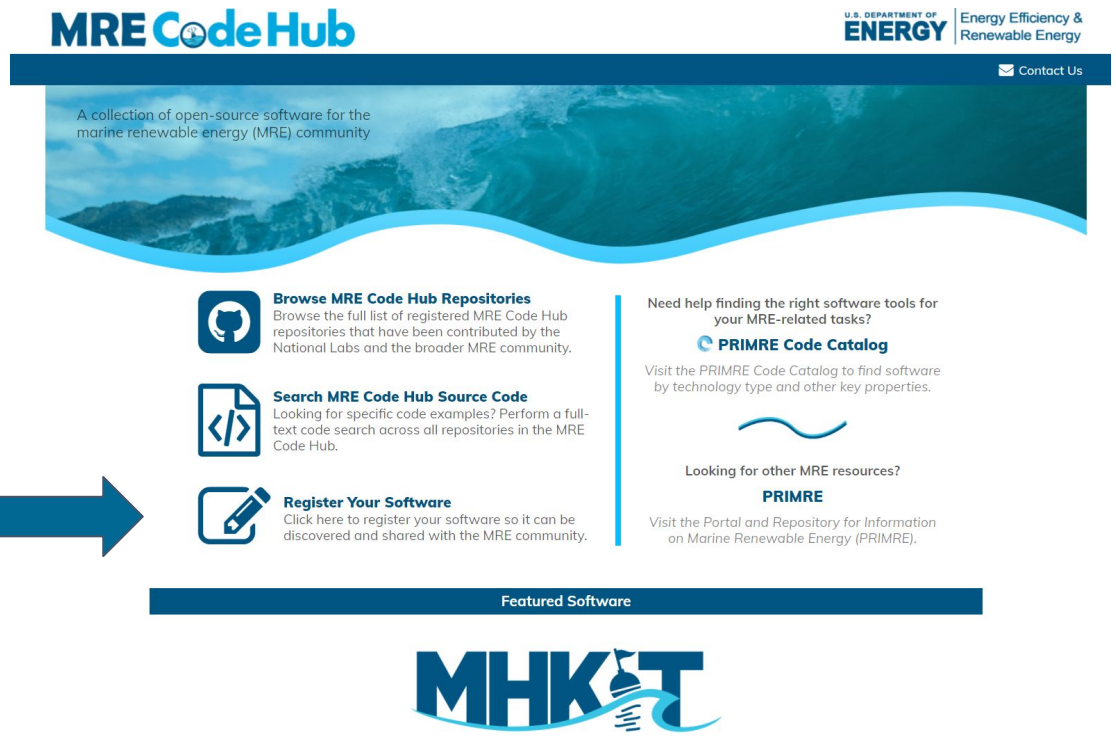
MRE Code Hub Submission

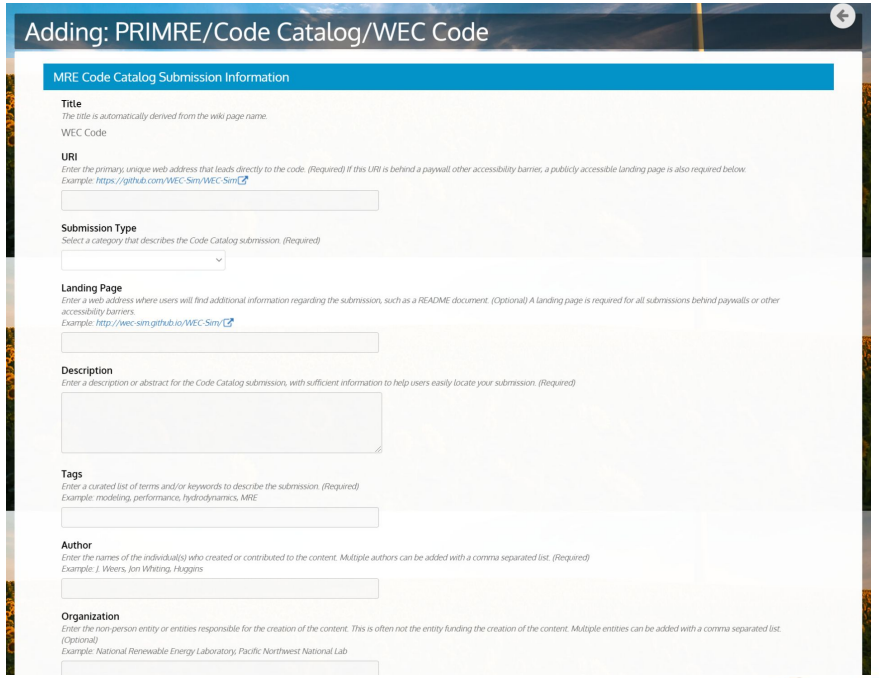
Launch MRE Code Submission Form

- Click Register Your Software link



Submission Form

- Same form used for MRE Code Catalog
- Open-source GitHub repositories will be added to MRE Code Hub GitHub repository by PRIMRE team



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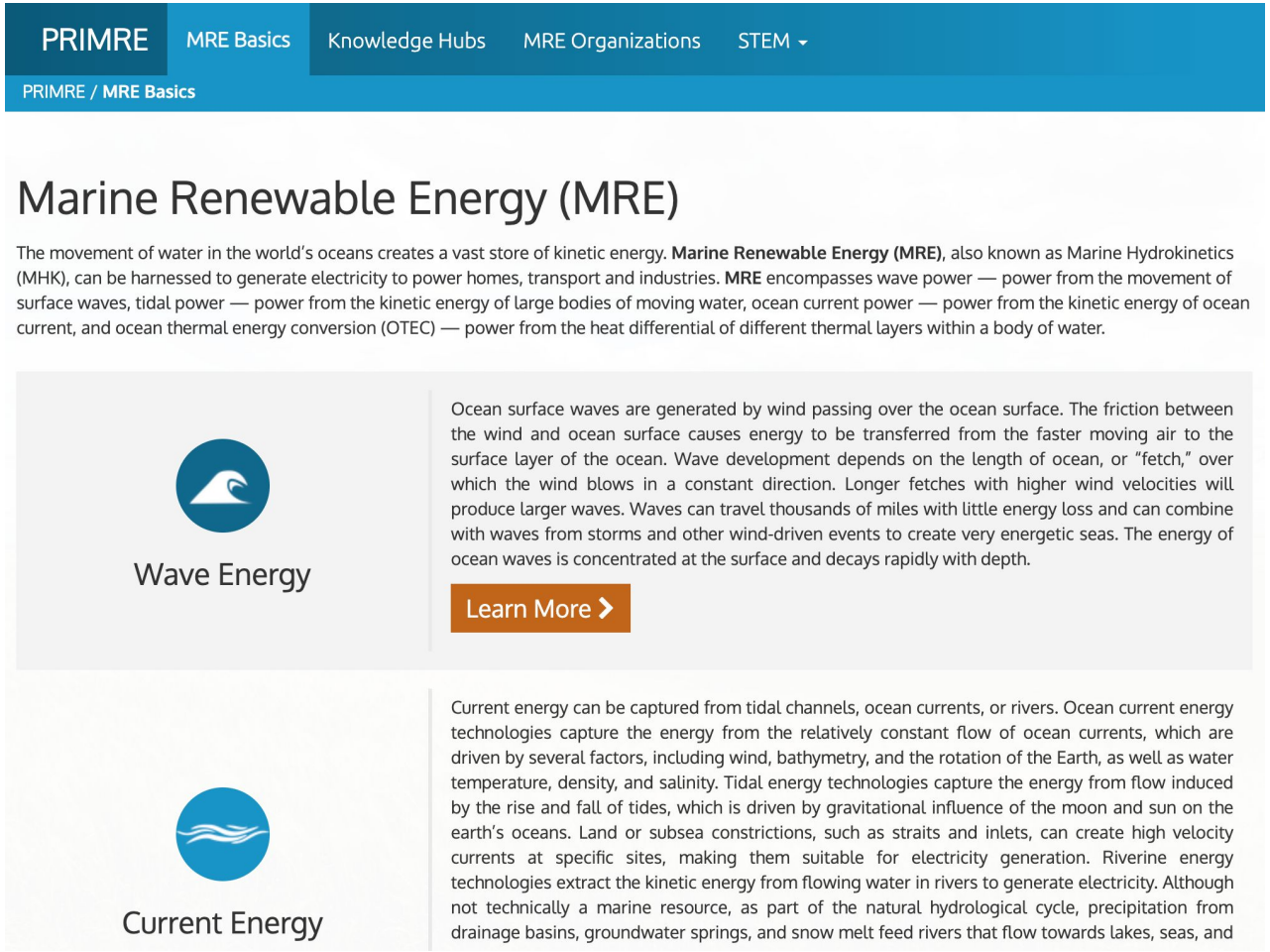
Contributing to the PRIMRE Wiki

Several of PRIMRE's Knowledge Hubs and other content pages exist in the PRIMRE wiki:

- **Marine Energy Projects Database**
- **Events**
- **MRE Basics**
- Other pages



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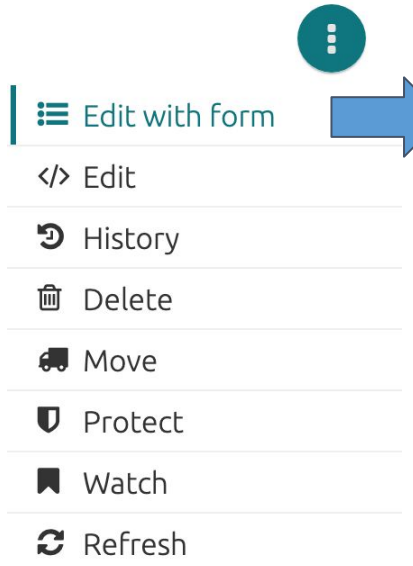
Contributing to the PRIMRE Wiki

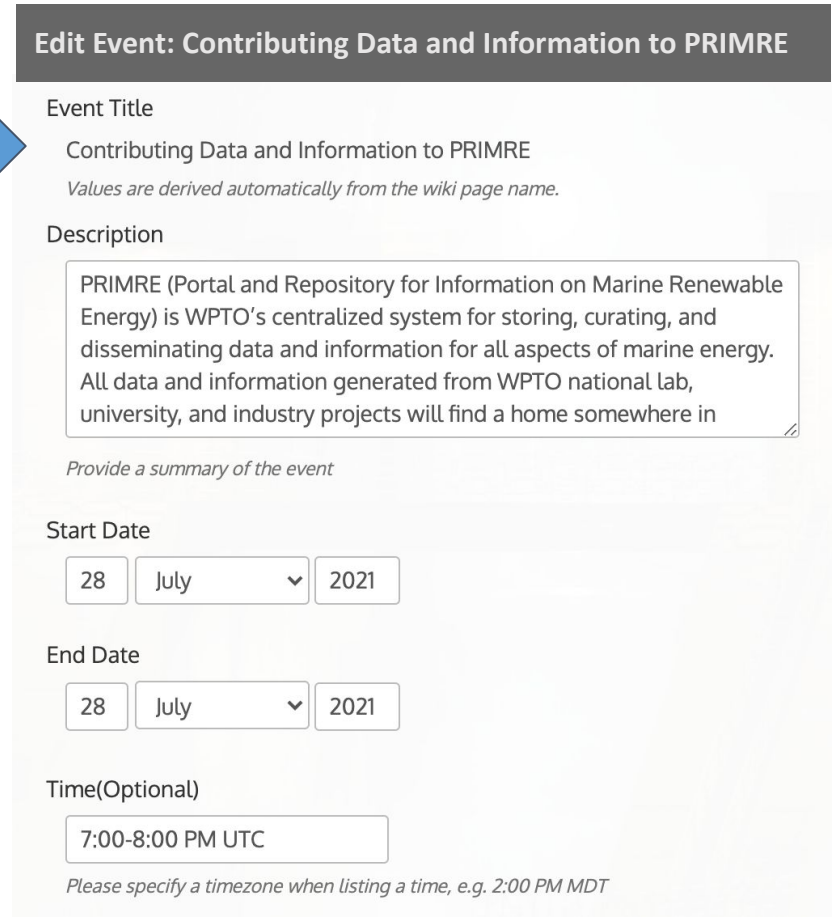
To contribute:

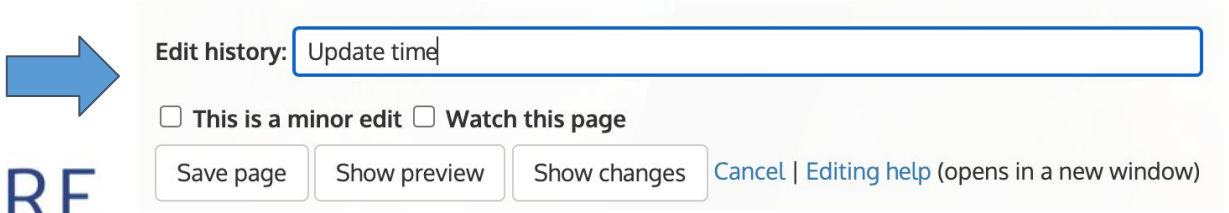
- find a specific “add” link
  - e.g. add an upcoming event on Events

- click the ⋮ in the upper right corner of the page.
  - **Edit with Form**
    - Complete a convenient web form
  - **Edit**
    - Use wiki syntax to add or edit content
    - More information on wiki editing via “Help” at the bottom of each page.

- add an edit history note and click **Save page**.







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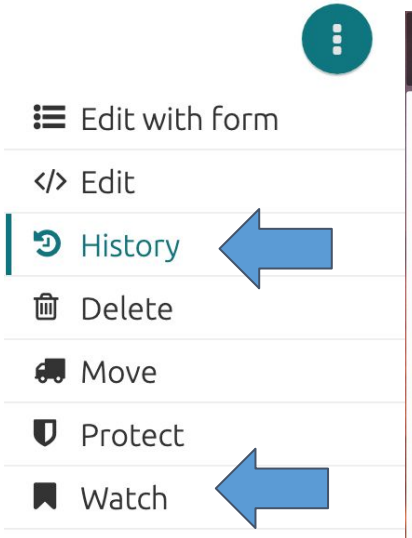
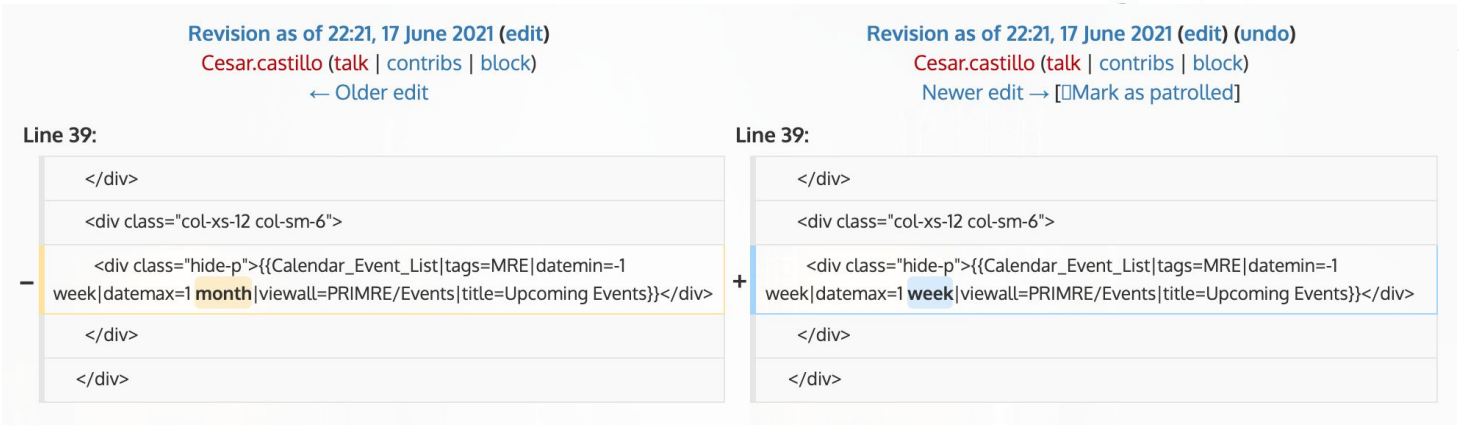
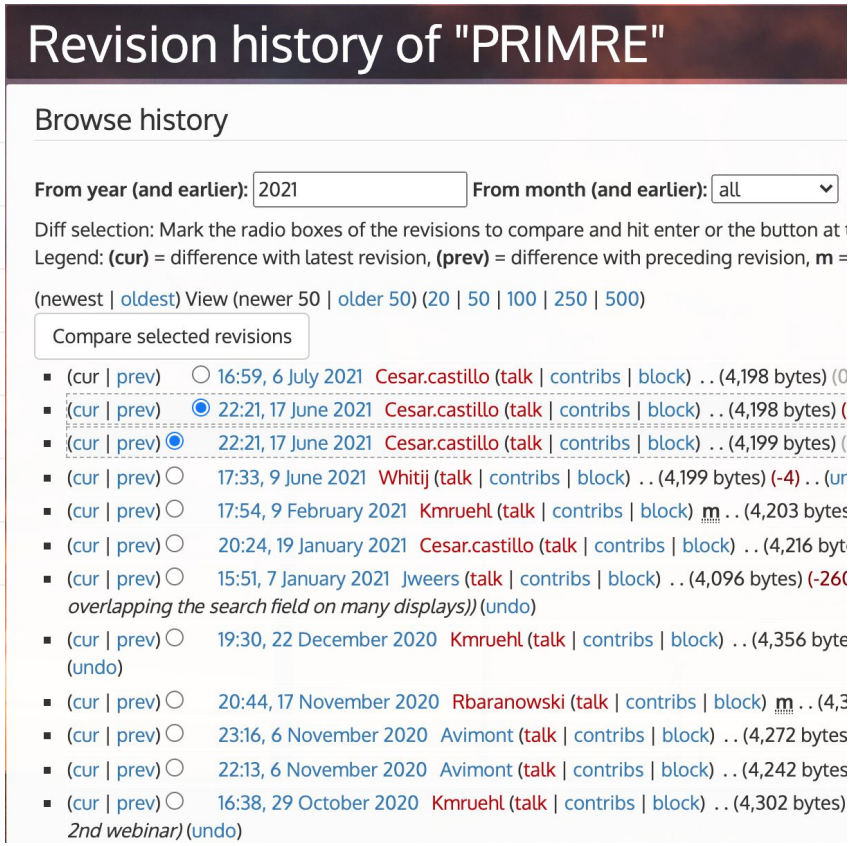
Contributing to the PRIMRE Wiki

More helpful actions:

- Full edit **history** available for each page
- You can **watch** a page to receive emails showing any updates, including who edited what and when.
- Available under the ⋮ menu.







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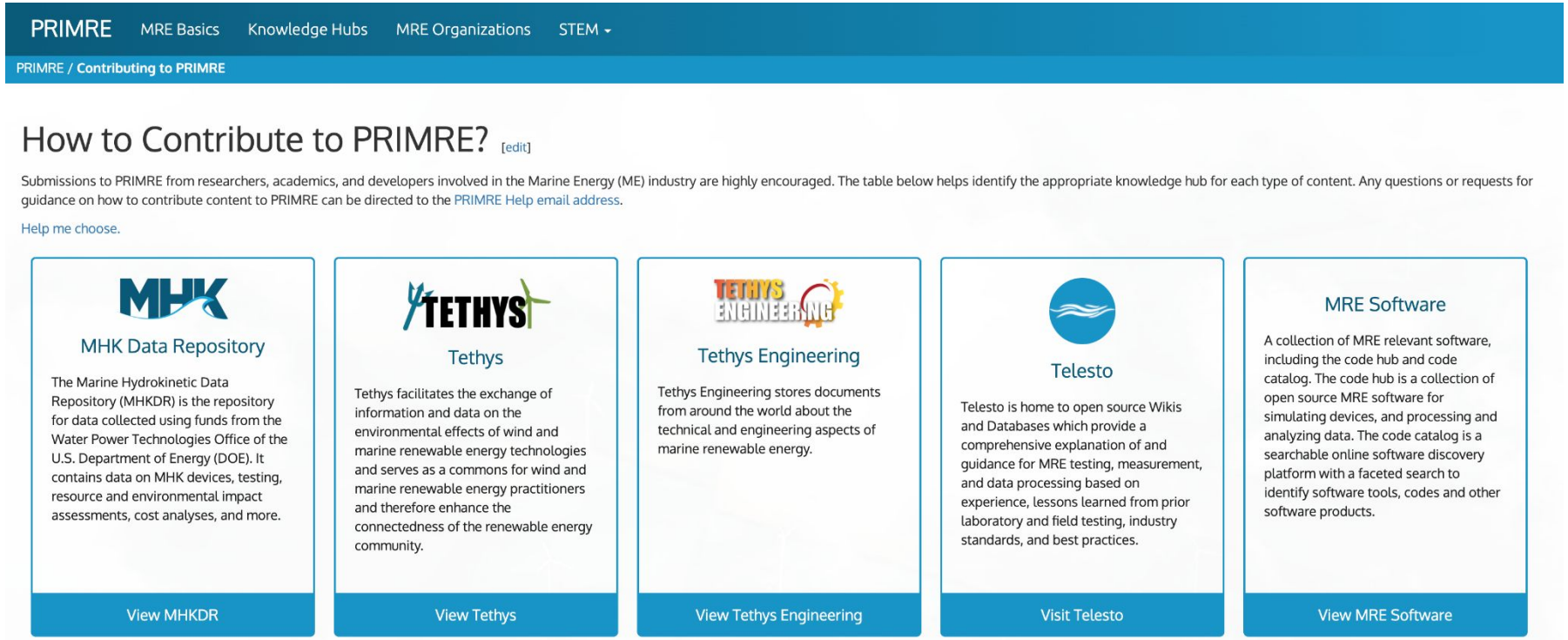
There are a lot of different ways to contribute to PRIMRE.
Not sure? Go to https://primre.org/Contribute and select **“Help Me Choose”**



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“Help Me Choose”

Answer a few simple questions to narrow down the options

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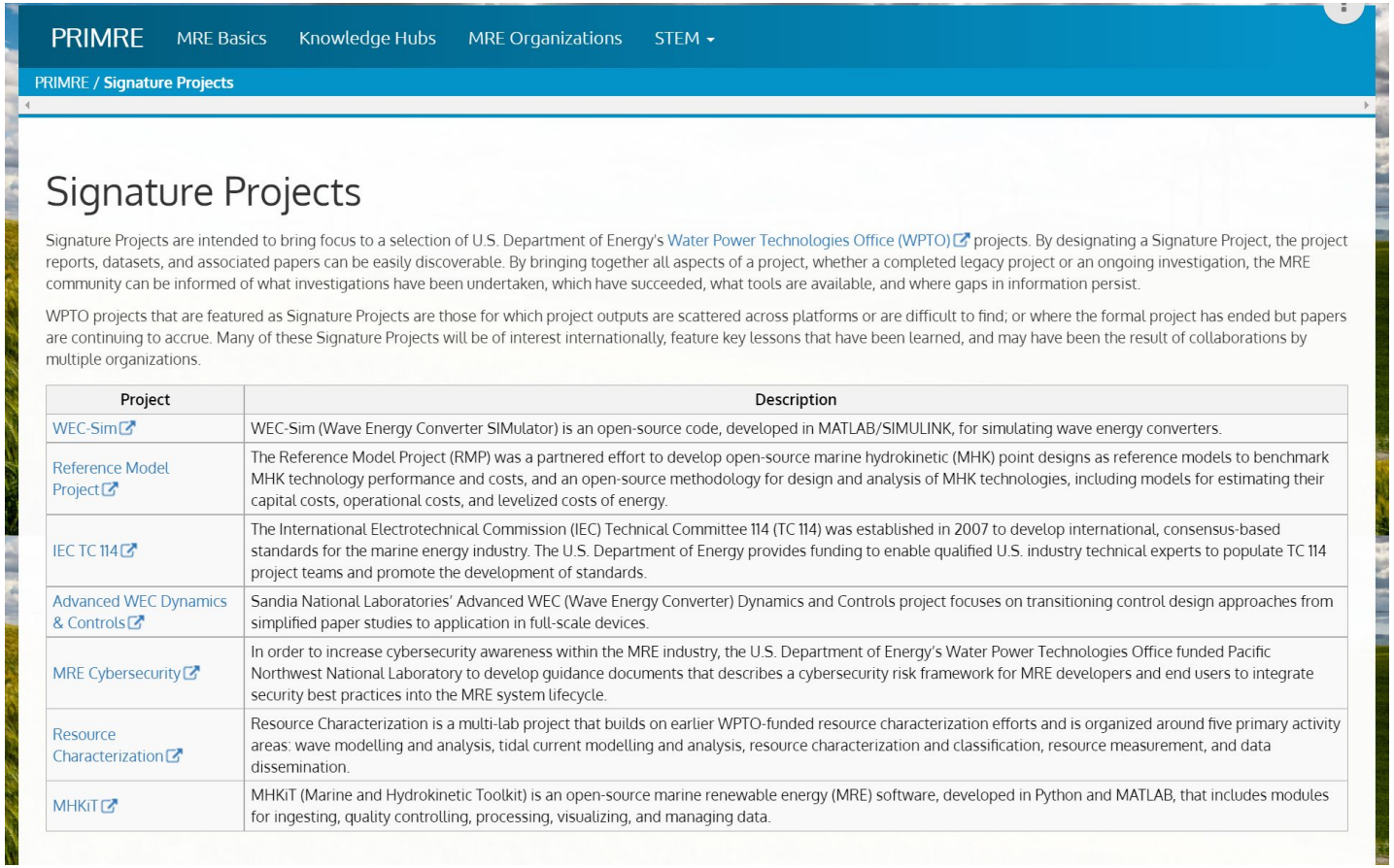
Contributing to PRIMRE

What should I *not* contribute?

- **Personally Identifiable Information (PII)**
  - Social security numbers
  - Bank account numbers
  - Home phone numbers and personal addresses of individuals not involved directly in the authoring of the data
  - "*Any piece of information or combination of pieces that could be used to compromise the identity of an individual*"
- **Data not suitable for (eventual) public release**

Consider a PRIMRE Signature Project

- Selected projects and initiatives funded by U.S. DOE WPTO
- All project reports, datasets, and associated papers are made more easily discoverable



PRIMRE MRE Basics Knowledge Hubs MRE Organizations STEM

PRIMRE / Signature Projects

Signature Projects

Signature Projects are intended to bring focus to a selection of U.S. Department of Energy's Water Power Technologies Office (WPTO) projects. By designating a Signature Project, the project reports, datasets, and associated papers can be easily discoverable. By bringing together all aspects of a project, whether a completed legacy project or an ongoing investigation, the MRE community can be informed of what investigations have been undertaken, which have succeeded, what tools are available, and where gaps in information persist.

WPTO projects that are featured as Signature Projects are those for which project outputs are scattered across platforms or are difficult to find; or where the formal project has ended but papers are continuing to accrue. Many of these Signature Projects will be of interest internationally, feature key lessons that have been learned, and may have been the result of collaborations by multiple organizations.

Project	Description
WEC-Sim	WEC-Sim (Wave Energy Converter SIMulator) is an open-source code, developed in MATLAB/SIMULINK, for simulating wave energy converters.
Reference Model Project	The Reference Model Project (RMP) was a partnered effort to develop open-source marine hydrokinetic (MHK) point designs as reference models to benchmark MHK technology performance and costs, and an open-source methodology for design and analysis of MHK technologies, including models for estimating their capital costs, operational costs, and levelized costs of energy.
IEC TC 114	The International Electrotechnical Commission (IEC) Technical Committee 114 (TC 114) was established in 2007 to develop international, consensus-based standards for the marine energy industry. The U.S. Department of Energy provides funding to enable qualified U.S. industry technical experts to populate TC 114 project teams and promote the development of standards.
Advanced WEC Dynamics & Controls	Sandia National Laboratories' Advanced WEC (Wave Energy Converter) Dynamics and Controls project focuses on transitioning control design approaches from simplified paper studies to application in full-scale devices.
MRE Cybersecurity	In order to increase cybersecurity awareness within the MRE industry, the U.S. Department of Energy's Water Power Technologies Office funded Pacific Northwest National Laboratory to develop guidance documents that describes a cybersecurity risk framework for MRE developers and end users to integrate security best practices into the MRE system lifecycle.
Resource Characterization	Resource Characterization is a multi-lab project that builds on earlier WPTO-funded resource characterization efforts and is organized around five primary activity areas: wave modelling and analysis, tidal current modelling and analysis, resource characterization and classification, resource measurement, and data dissemination.
MHKiT	MHKiT (Marine and Hydrokinetic Toolkit) is an open-source marine renewable energy (MRE) software, developed in Python and MATLAB, that includes modules for ingesting, quality controlling, processing, visualizing, and managing data.

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Consider a PRIMRE Signature Project

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Home » Glossary » Help » Resource » Resource Characterization

Signature Projects are intended to bring focus to a selection of U.S. Department of Energy's **Water Power Technologies Office (WPTO)** projects. By designating a Signature Project, the project reports, datasets, and associated papers can be easily discoverable. By bringing together all aspects of a project, whether a completed legacy project or an ongoing investigation, the MRE community can be informed of what investigations have been undertaken, which have succeeded, what tools are available, and where gaps in information persist.

Resource Characterization

Project Purpose

Since 2016, the Resource Characterization project has been motivated by a recognition that detailed resource data is critical to the success of the marine energy industry. This Resource Characterization project also builds on **earlier WPTO-funded resource characterization efforts** published between 2011 and 2015. For more information on the work being done by individuals labs, check out **NREL's Characterization page**, **PNNL's Characterization page**, and **Sandia's Characterization page**.

Signature Project

Title:	Resource Characterization
Status:	Ongoing
Start Date:	January 2016
End Date:	September 2022
Organization:	National Renewable Energy Laboratory (NREL), Pacific Northwest National Laboratory (PNNL), Sandia National Laboratories (SNL)
Point of Contact:	Levi Kilcher, Zhaoqing Yang, Vincent Neary

Project Description

Phase I of this project (2016–2018) collected and generated a large amount of resource data, developed high-resolution wave and tidal models, and developed a wave energy resource classification scheme. In Phase 2 of this project (2019–2022), the goal is to lower the cost of marine energy and accelerate marine energy technology development by refining, extending, and disseminating the data necessary for engineering robust and efficient marine energy devices and projects.

Project Methods

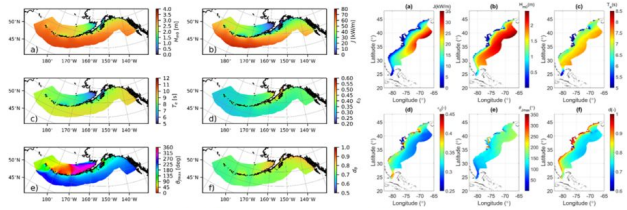
The project is organized around five primary activity areas: wave modelling and analysis, tidal current modelling and analysis, resource characterization and classification, resource measurement, and data dissemination. PNNL leads the modelling efforts, Sandia leads characterization and classification work, and NREL serves as the lead for resource measurements, data dissemination, and the overall project. All of these activities are conducted with careful attention to best practices and methods recommended by the **International Electrotechnical Commission's (IEC) Technical Committee (TC) 114**. The project also has several public and private partners and holds quarterly calls with a steering committee of international experts and U.S. industry representatives to solicit guidance on key project decisions.

Key Findings/Applications

The data and tools generated by this project can be used for device design and optimal siting processes for technology developers, economic assessments for project developers, energy assessments (power supply and energy portfolio diversification) for regional planners and policy makers, operational reliability and economic assessments for utilities and investors, environmental impacts studies for regulatory agencies.

Wave Modelling and Analysis

- High-resolution wave models for all of the US coastal regions extending to the exclusive economic zone (EEZ) (**Allahdadi et al 2019**, **Wu et al. 2020**, **Yang et al. 2020**, **Garcia-Medina et al. 2021**, **Li et al. 2021**). All hindcast data are in the process of being made publicly available on the **Open Energy Data Initiative's Cloud server**. Data include six IEC parameters (significant wave height, mean wave energy period, omni-directional wave power, spectral width, maximum energy direction, directionality coefficient) and several other variables (mean peak wave period, mean zero-crossing period, mean absolute period) and extend 32 years (1979-2010) in 3-hour temporal resolution, with horizontal spatial resolution as fine as 200 m in shallow water.



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Home » Signature Projects » Connections » MHKiT

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MHKiT

Project Purpose

The ability to collect, ingest, condition, reduce, quality control, process, visualize, and store data is critical at all stages of marine energy research and technology/project development. MHKiT empowers the marine energy industry by providing a toolbox of marine energy specific functionality that enables rapid data processing using opensource, verified, and industry standard data handling, allowing for the community to collaboratively develop and expand MHKiT based on industry needs.

Signature Project

Title:	MHKiT
Status:	Ongoing
Start Date:	September 2019
Source:	External Link
Organization:	National Renewable Energy Laboratory (NREL), Pacific Northwest National Laboratory (PNNL), Sandia National Laboratories (SNL)
Point of Contact:	Rebecca Fao and Sterling Olson

Project Description

MHKiT is an open-source marine energy software, developed in Python and MATLAB, that includes modules for ingesting, quality controlling, processing, visualizing, and managing data. **MHKiT-Python** and **MHKiT-MATLAB** provide robust and verified functions in both Python and MATLAB that are needed by the marine energy community to standardize data processing. Calculations and visualizations adhere to International Electrotechnical Commission (IEC) technical specifications and other guidelines.

MHKiT is developed as a collaboration between the National Renewable Energy Laboratory (NREL), Pacific Northwest National Laboratory (PNNL), and Sandia National Laboratories (SNL). Development of MHKiT is funded by the U.S. Department of Energy's Water Power Technologies Office.

Project Methods

The MHKiT team leverages previous efforts by the National Labs and guidance from the IEC standards to develop robust and standardized code to be used by the marine energy community. By being an open source project, hosted on GitHub, the marine energy community can take an active role in defining future development in MHKiT but submitting ideas for functionality and code for review to be included in MHKiT. More functionality will continue to be added to MHKiT as the industry evolves, and new standardized code needs emerge.

Key Findings/Applications

MHKiT provides the following benefits to the marine energy community:

- Eliminates the common code creation across the marine energy field
- Offers standardized, referenceable, and readable code base
- Enables rapid data processing
- Creates a data flow of quality control (QC), analysis, and visualization
- Offers a common development platform across the marine energy community where issues are discussed, and features are expanded
- Assists developers in device certification for insurance, regulator bodies, and investors

Associated Marine Energy Engineering Documents

Total results: 4

Content Type: - Any - **Search:** **Apply**

Title	Author	Date	Type of Content	Technology	Collection Method	Application
MHKiT-MATLAB: Introduction and Demonstration	**Fao, R., Olson, S.**	February 2021	Presentation	**Marine Energy, Current, Wave**	**Field Data, Lab Data, Modeling**	
MHKiT-Python: Introduction and Demonstration	**Fao, R., Olson, S.**	February 2021	Presentation	**Marine Energy, Current, Wave**	**Field Data, Lab Data, Modeling**	

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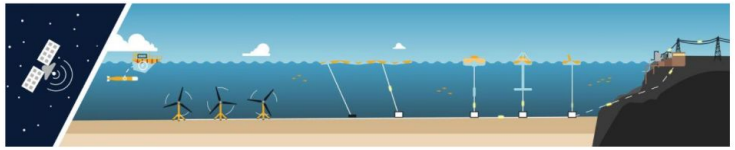
Home » Signature Projects » Connections » MRE Cybersecurity

Signature Projects are intended to bring focus to a selection of U.S. Department of Energy's **Water Power Technologies Office (WPTO)** projects. By designating a Signature Project, the project reports, datasets, and associated papers can be easily discoverable. By bringing together all aspects of a project, whether a completed legacy project or an ongoing investigation, the MRE community can be informed of what investigations have been undertaken, which have succeeded, what tools are available, and where gaps in information persist.

MRE Cybersecurity



Signature Project

Title:	MRE Cybersecurity
Status:	Ongoing
Start Date:	January 2020
End Date:	April 2021
Organization:	Pacific Northwest National Laboratory (PNNL)
Point of Contact:	Fleurdeliza De Peralta

Project Purpose

The purpose of the project is to provide guidance to secure marine renewable energy (MRE) systems from cyberattacks and improve the resiliency of MRE systems as a predictable, affordable, and reliable source of energy from oceans and rivers.

Project Description

The advanced operational and information technology used in MRE system designs creates the potential for a cyberattack. Cyber threat actors with malicious intent could target vulnerable MRE systems to gain unauthorized access to data or disrupt operation. In order to increase cybersecurity awareness within the MRE industry, the U.S. Department of Energy's Water Power Technologies Office (WPTO) funded Pacific Northwest National Laboratory (PNNL) to develop guidance documents that describes a cybersecurity risk framework for MRE developers and end users to integrate security best practices into the MRE system lifecycle (e.g., design, construction, operation, and decommissioning). The guidance documents provided an approach to determine the MRE system's cybersecurity risk (Low, Moderate, or High) and identified risk-based best practices to secure the Information Technology and Operational Technology components.

Project Methods

The research involved identifying different network architectures and configurations for an MRE system in order to determine the types of cyber threats to evaluate. Information on MRE system designs is obtained from open source and formal request for information from MRE stakeholders (e.g., system developers and end-users).

The project activities included two focus areas: (1) Identify Cybersecurity Vulnerabilities and (2) Develop Cybersecurity Guidance. The Cybersecurity Framework developed by the National Institute of Standards and Technology (NIST) was followed to generate best practice security controls that were included in the MRE Cybersecurity Guidance. The guidance documents developed from this project were based on initial engagements with MRE stakeholders and knowledge of components used in MRE systems. As MRE system technology evolves and cyber threats increase, the best practice security measures developed from this project could be used, in conjunction with other industry developed guidance.

Key Findings/Applications

de Peralta et al. 2020a provides the results of Focus 1 and describes a framework for determining the cybersecurity risk of an MRE system and its end use. The framework was based on MRE system assets, network architecture, and operational configurations; the vulnerabilities that the assets will have to a cyberattack based on known threats to industrial control systems in the energy sector; and the consequences of a cyberattack on the end user. The resultant framework can be used by MRE developers and end users to determine their cybersecurity risk posture.

de Peralta et al. 2020b provides the results of Focus 2 and describes cybersecurity best practices commensurate with the risk of affecting the business and mission objectives of the end user. The cybersecurity best practices implement the controls of NIST CSF (e.g., identify, detect, protect, respond, and recover). The methods to protect MRE systems were based on recommended strategies to mitigate known threats to the energy sector and security measures to protect IT/OT systems. The cybersecurity best practices were tailored to protect MRE systems and their end use from a cyberattack.

PRIMRE

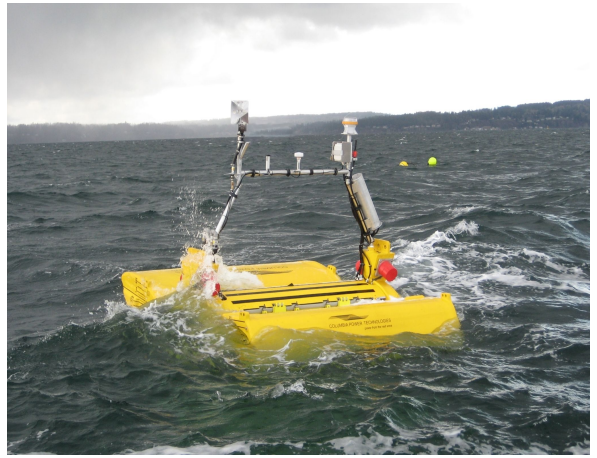
NREL NATIONAL RENEWABLE ENERGY LABORATORY

Pacific Northwest NATIONAL LABORATORY

Sandia National Laboratories

PRIMRE is here for you!

- **PRIMRE**: brings together information and data pertinent to marine energy
- Divided into **knowledge hubs**, based on the type of information
- Managed and updated by the national labs for WPTO
- **Central location** for finding data, analyses, papers, reports, and guidance
- Success depends on **contribution to and use of information**



PRIMRE

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Pacific Northwest NATIONAL LABORATORY

Sandia National Laboratories

Next Steps in PRIMRE

- New Knowledge Hub: Marine Energy Atlas
- Lessons learned
- International databases, GIS for Ocean Energy Systems
- Redesign Marine Energy Project Database

PRIMRE Team

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