



# Empowering Marine Energy Research with AskPRIMRE

PRIMRE's New AI Research Assistant

PRIMRE Principal Investigators

Jon Weers, Andrea Copping, Cesar Castillo



August 7, 2024

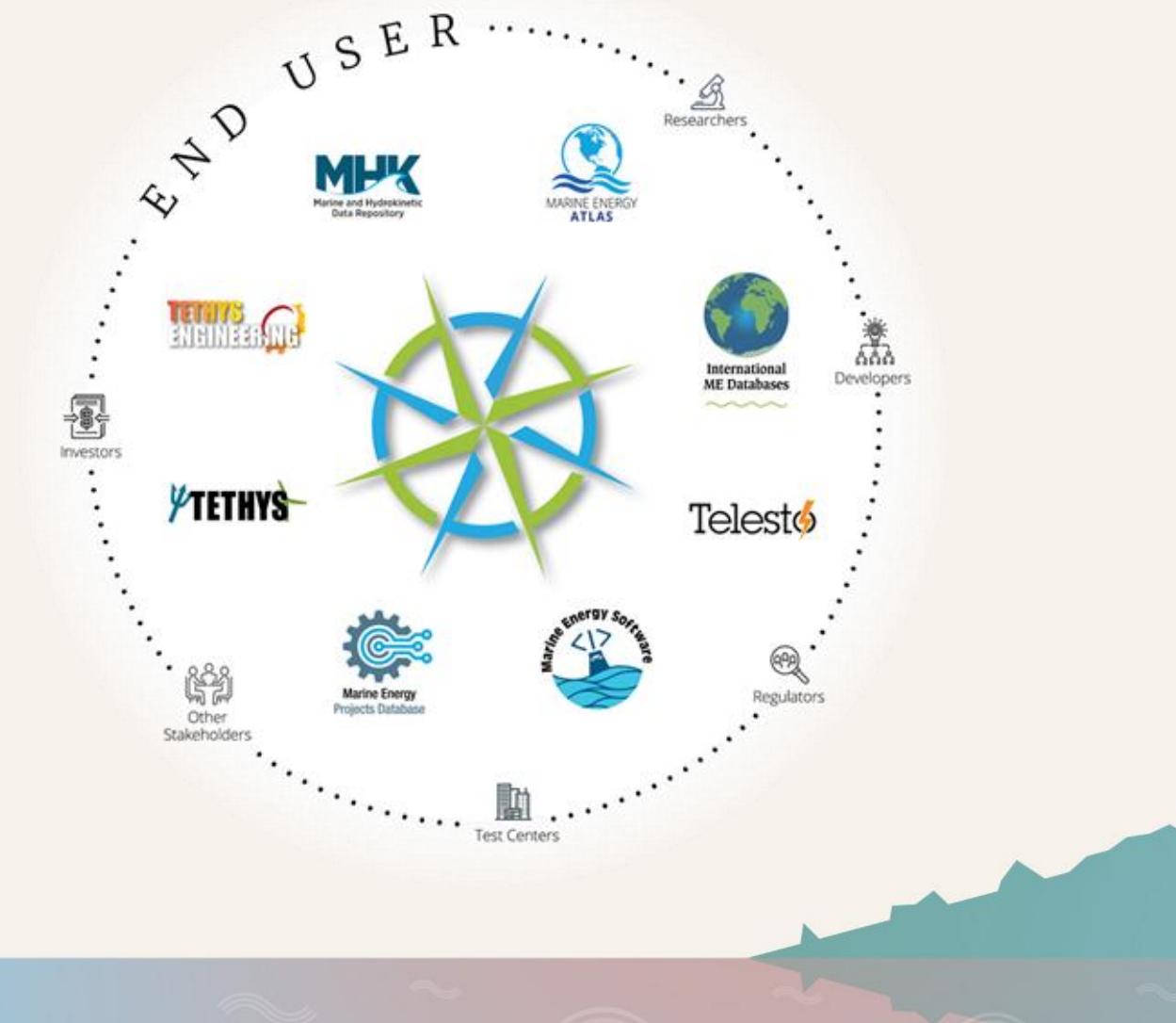
UMERC + METS 2024



**The Portal and Repository of Information on Marine Renewable Energy (PRIMRE)** provides access to marine energy data, information, and resources to help advance the international marine energy industry, including:

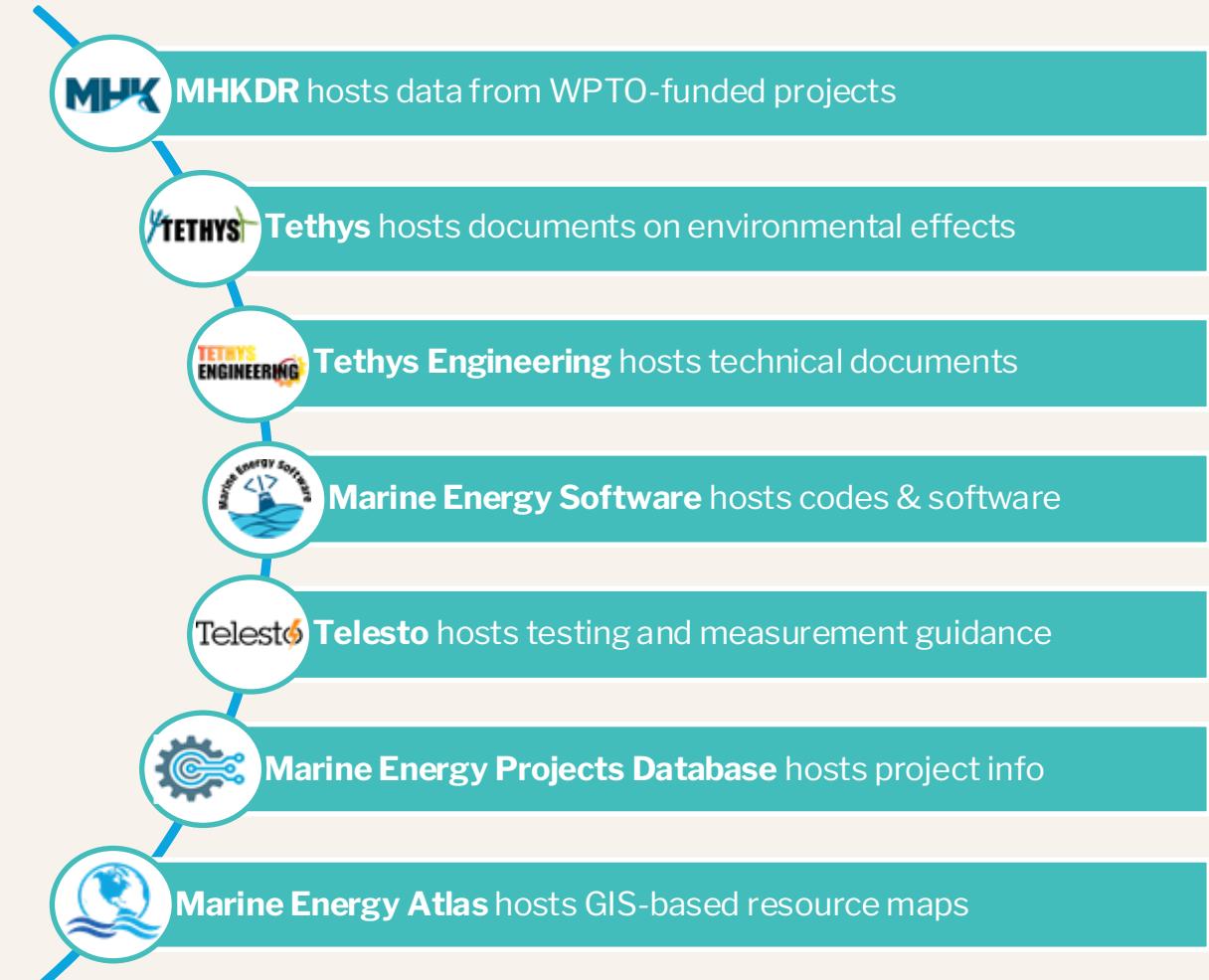
- Knowledge Hubs
- Events Calendar
- Archived Webinars
- Educational Resources
- Data, Docs, Tools, & Software

Funded by the U.S. Department of Energy, Water Power Technologies Office and led by three national labs.



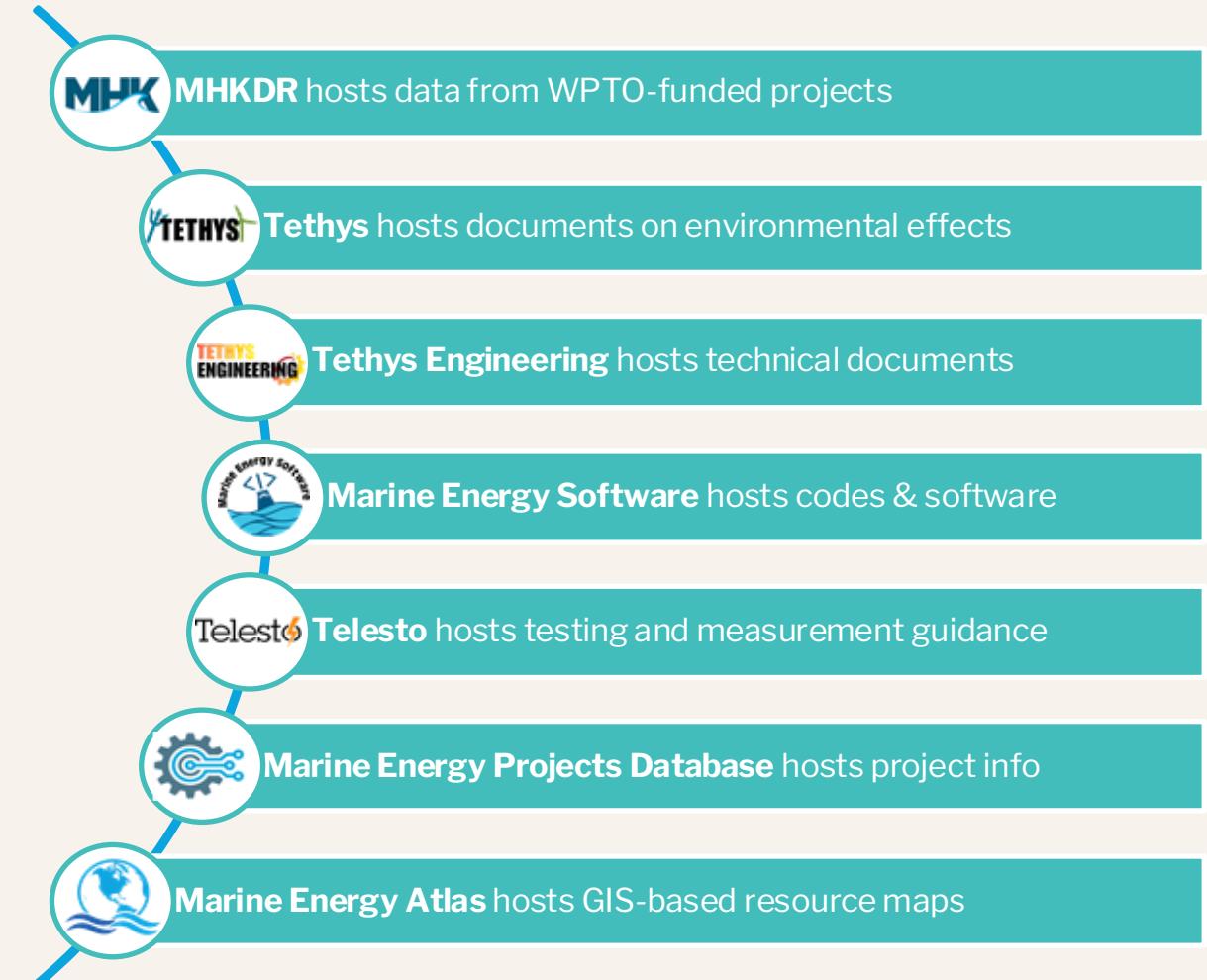
# PRIMRE

- Each **Knowledge Hub** houses a different type and format of information related to marine energy.
- Several Knowledge Hubs were developed under other projects, but all have been integrated and improved.
- PRIMRE has a **one-stop search** that allows users to find data and information throughout the system.



# PRIMRE

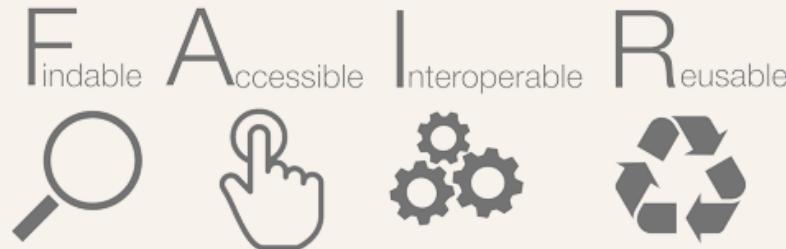
- Each **Knowledge Hub** houses a different type and format of information related to marine energy.
- Several Knowledge Hubs were developed under other projects, but all have been integrated and improved.
- PRIMRE has a **one-stop search** that allows users to find data and information throughout the system.



# Background

**PRIMRE adheres to FAIR and FARR data principals,**  
to ensure that data and information are:

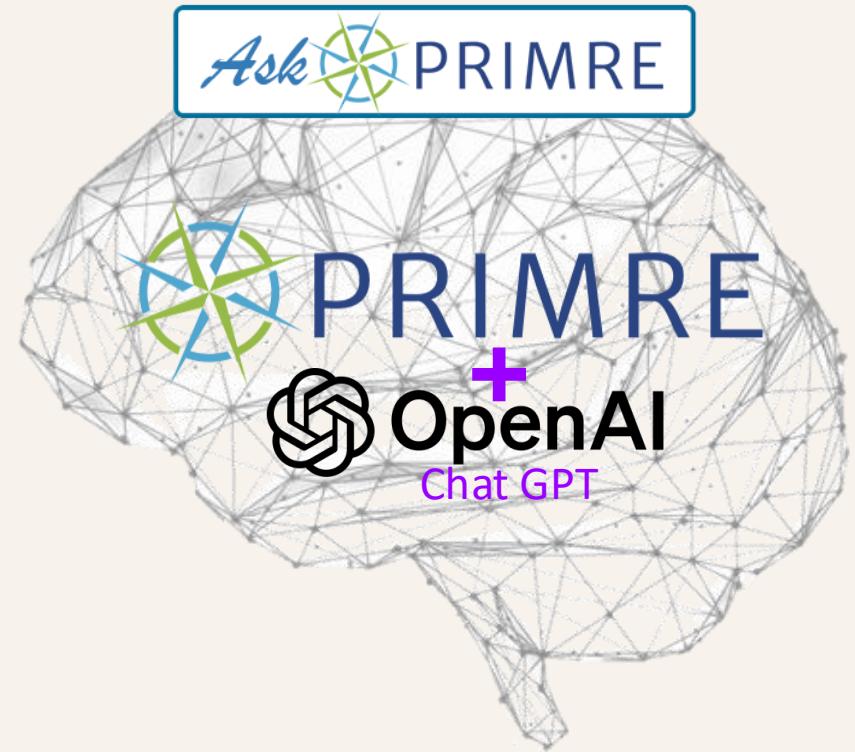
Findable  
Accessible  
Interoperable  
Reusable



In addition to FAIR, PRIMRE metadata is also:  
**AI Ready, and**  
**Reproducible**



Efforts to meet these principals help ensure that PRIMRE data is discoverable, universally accessible, machine-readable, and ready for AI and machine learning applications.



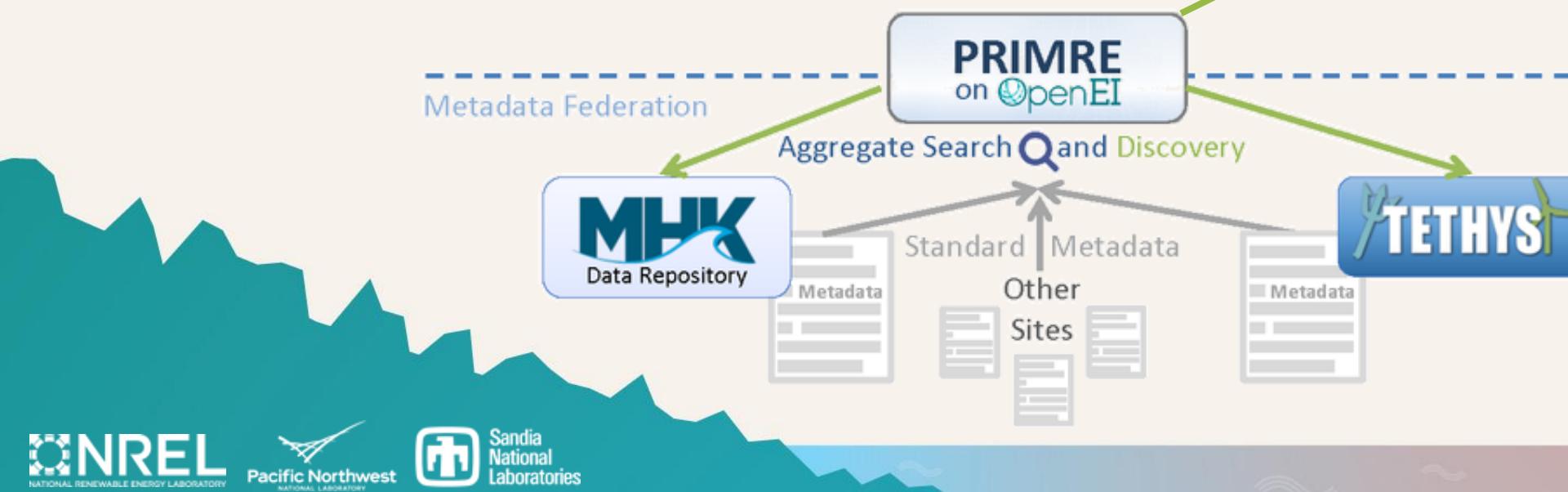
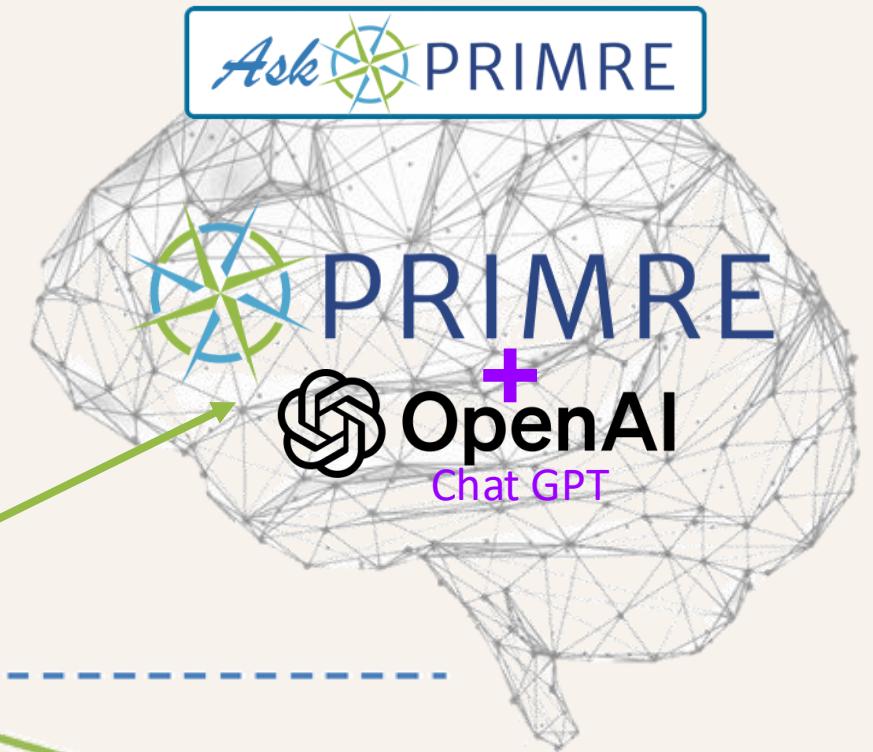
# Background

## PRIMRE Centralized Search

<https://primre.org/search>

- Search across all PRIMRE knowledge hubs and partners
- Data sharing between U.S. and international databases
- Uses PRIMRE's standardized metadata schema, based on DCAT + marine energy terms:

[https://primre.org/Developer\\_Documents#schema](https://primre.org/Developer_Documents#schema)





## AI-powered Research Assistant

Two primary goals:

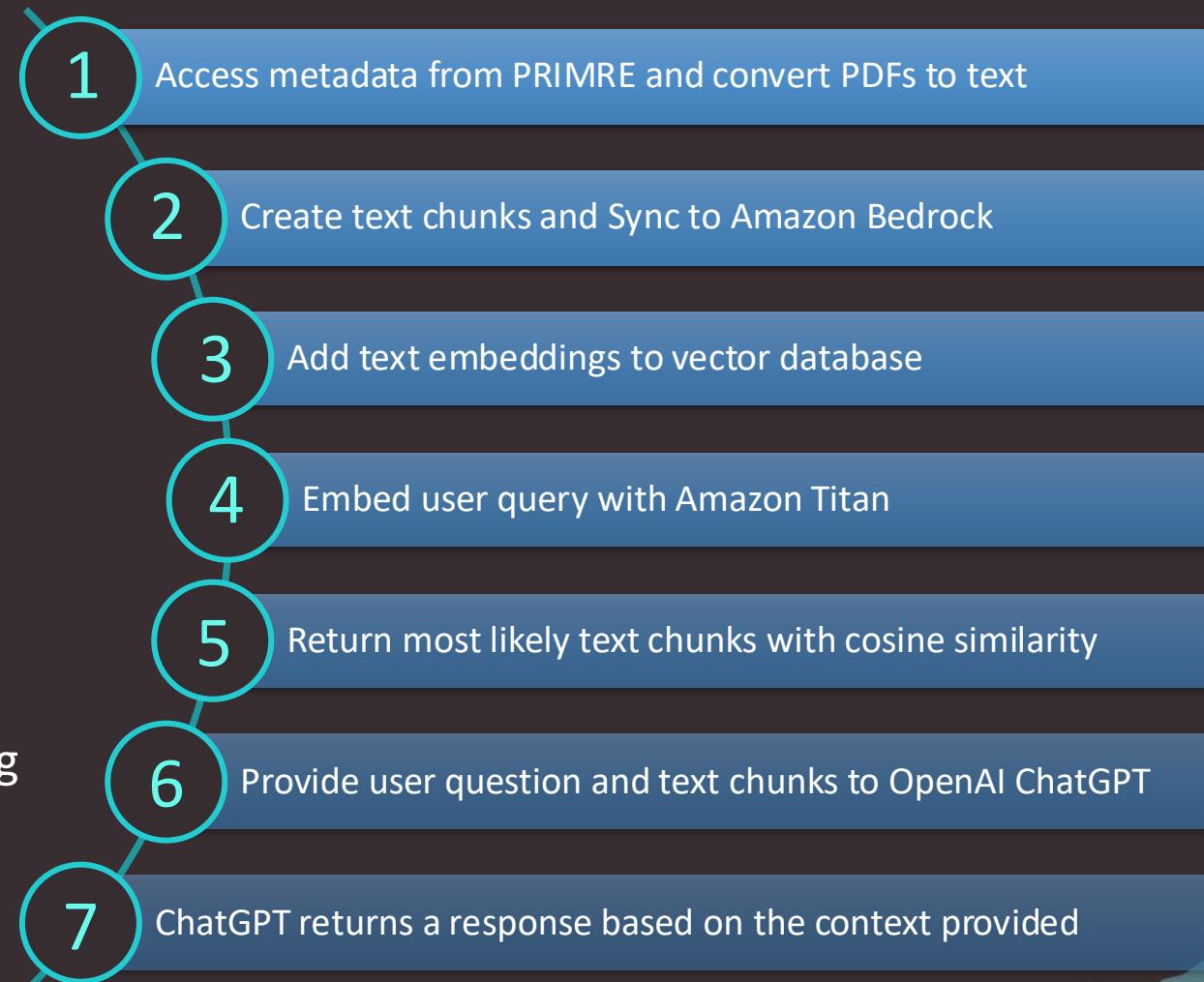
- 1 Help users get quick answers to contextual questions about data
- 2 Help guide users to insights beyond simple keyword searches

Worked with the PRIMRE Steering Committee to determine the best implementation.

### The “Research Assistant” concept

- Less conversational, more factual.
- Trained on PRIMRE metadata and supporting documents

### AskPRIMRE Data Flow





## AI-powered Research Assistant

- Able to pull answers from PRIMRE data, articles, knowledge hubs, and supporting documents.
- Will not speculate
- Will not go to the internet for answers
- Only pulls from vetted, curated information
- Always cites its sources

### Limitations:

- Cannot do math or analysis
- Cannot provide novel insights
- Answers limited to published materials



## Test Question #1: *“What is WEC-Sim?”*



WEC-Sim (Wave Energy Converter SIMulator) is an open-source code for simulating wave energy converters, jointly developed by the National Renewable Energy Laboratory and Sandia National Laboratories in the United States. It is developed in MATLAB/SIMULINK with Simscape Multibody, which solves the multi-body dynamics of the system. WEC-Sim is designed to predict, analyze, and optimize WEC dynamics and power performance. It can handle floating body hydrodynamics, mechanical and electrical power generation methods, advanced control implementation, mooring systems, and other unique applications.

### Sources:

- [Review of WEC-Sim Development and Applications](#)
- [Advanced Features and Recent Developments in the WEC-Sim Open-Source Design Tool](#)
- [Recent Additions in the Modeling Capabilities for the WEC-Sim-v1.1 Wave Energy Converter Design Tool](#)



## Test Question #2: *“What is control co-design?”*

### PRIMRE Answer:

Control co-design (CCD) is an advanced design methodology that aims to optimize the system design and system controller concurrently rather than sequentially or iteratively. This approach considers the parameters that affect system performance more comprehensively at every stage of the design process, enabling more efficient and effective system optimization. In the context of marine hydrokinetic turbines, control co-design helps in developing robust, cost-competitive turbine systems by combining multiple models across a range of fidelities and considering the coupling between different aspects of the design, such as hydrodynamics, structural dynamics, power electronics, and controls.

#### Sources:

- [Development of a Control Co-Design Modeling Tool for Marine Hydrokinetic Turbines](#)
- [Integrated physical design, control design, and site selection for an underwater energy-harvesting kite system](#)



## Test Question #3: *“What is the main environmental concern of marine energy development?”*



There is no single main environmental concern of marine energy development, as several key environmental concerns are associated with it. These include:

1. Collision risk: Potential for marine animals to collide with marine energy devices, such as tidal turbines or wave energy converters.
2. Underwater noise: Noise generated by the operation of marine energy devices, which can affect marine animals' behavior, communication, and navigation.
3. Electromagnetic fields (EMFs): EMFs generated by underwater cables and devices, which can affect the behavior and navigation of marine animals sensitive to electromagnetic fields.
4. Habitat changes: Alterations to marine habitats due to the installation, operation, and decommissioning of marine energy devices, which can affect marine species and ecosystems.
5. Changes in water circulation and sedimentation: Marine energy devices can alter water circulation patterns and sediment transport, potentially affecting marine habitats and ecosystems.

These concerns need to be carefully monitored and managed to minimize the potential negative impacts on marine life and ecosystems.



**Test Question #3: "What is the main environmental concern of marine energy development?"**

**Ask PRIMRE Answer: (continued)**

These concerns need to be carefully monitored and managed to minimize the potential negative impacts on marine life and ecosystems

Sources:

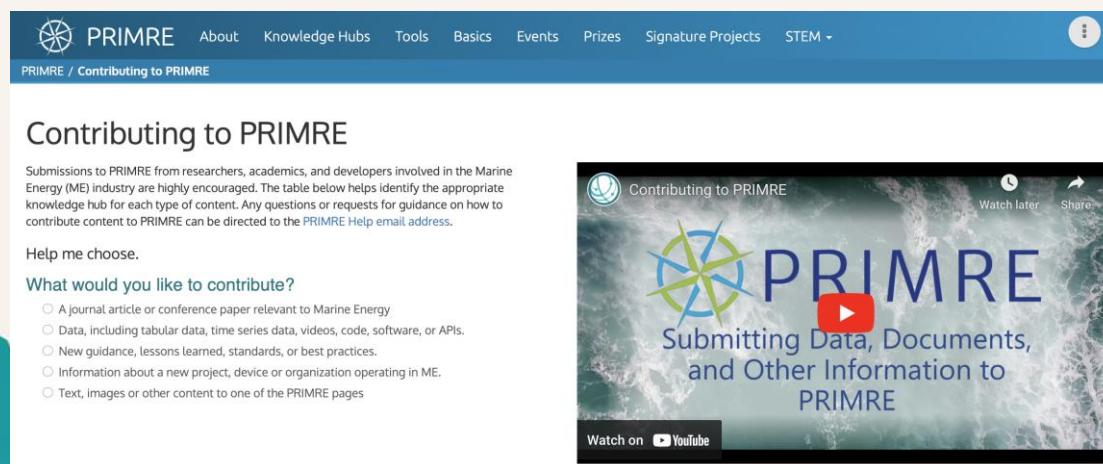
- [Taking a Broader Look at Environmental and Ecological Effects of Marine Energy Development](#)
- [Concerns in Marine Renewable Energy Projects](#)
- [Environmental Effects of Marine Energy Development on Physical Systems](#)
- [Managing Environmental Effects to Facilitate Marine Renewable Energy Development](#)

# Get Connected

## Contribute to PRIMRE

[https://primre.org/Contributing\\_to\\_PRIMRE](https://primre.org/Contributing_to_PRIMRE)

- A permanent home for your data and information
- Disseminated to a network of data sharing partners
- Accepting data, publications, code, software, best practices, lessons learned, and more.



Contributing to PRIMRE

Submissions to PRIMRE from researchers, academics, and developers involved in the Marine Energy (ME) industry are highly encouraged. The table below helps identify the appropriate knowledge hub for each type of content. Any questions or requests for guidance on how to contribute content to PRIMRE can be directed to the PRIMRE Help email address.

Help me choose.

What would you like to contribute?

- A journal article or conference paper relevant to Marine Energy
- Data, including tabular data, time series data, videos, code, software, or APIs.
- New guidance, lessons learned, standards, or best practices.
- Information about a new project, device or organization operating in ME.
- Text, images or other content to one of the PRIMRE pages

## Subscribe to the PRIMRE Blast

Stay up to date on the latest marine energy news, events, data, publications, and improvements to PRIMRE.



# Thank You!

## PRIMRE PIs:

- Jon Weers ([jon.weers@nrel.gov](mailto:jon.weers@nrel.gov))
- Andrea Copping ([andrea.copping@pnnl.gov](mailto:andrea.copping@pnnl.gov))
- Cesar Castillo ([cesar.castillo@sandia.gov](mailto:cesar.castillo@sandia.gov))

## PRIMRE Team:

**NREL:** Hanna Fields, Sean Morris, Erika Curry-Elrod, Jay Huggins, and Austin Venhuizen

**PNNL:** Jonathan Whiting, Lysel Garavelli, Hayley Farr, Fadia Ticano Rollano, Curtis Anderson, and Dominick DeCanio

**Sandia:** Kelley Ruehl, Will Peplinski, and Megan Anderson

The National Renewable Energy Laboratory is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC, under contract No. DE-AC36-08GO28308. Pacific Northwest National Laboratory is operated by Battelle for the U.S. Department of Energy under contract DE-AC05-76RL01830. Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

