Pacific Northwest
NATIONAL LABORATORY

Marine Energy to Chemical Storage via Electrochemical Pathways – PNNL's "Seedling" Work

Rob Cavagnaro, PNNL Marine Energy Subsector Lead

NHA
National Hydropower Association

WATER.POWER.WEEK.
WASHINGTON, D.C. • MARCH 13-15, 2024
CAPITAL HILTON • WATERPOWERWEEK.COM

Introduction to PNNL

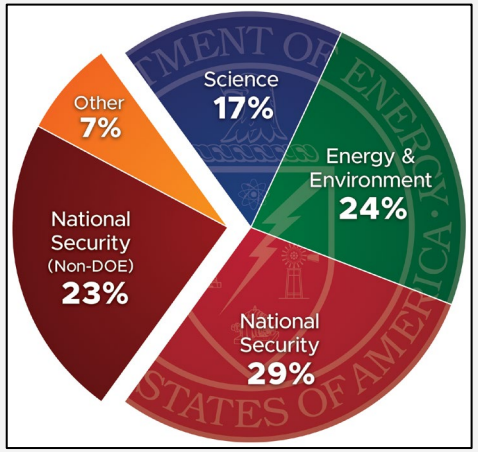
- PNNL is one of DOE's most diversified national laboratories

$1.5B Spending

6,088 Staff

1,980 Peer-reviewed Publications

301 Invention Disclosures

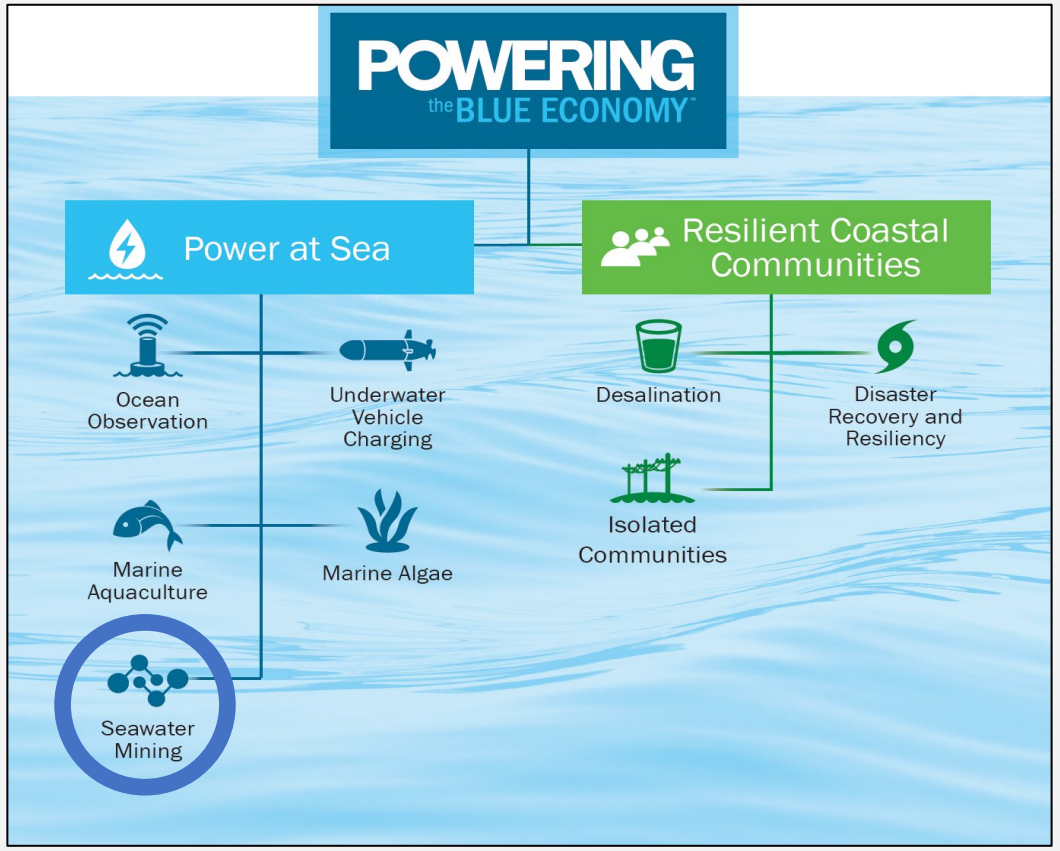


FY 2023 Spending

PNNL-Sequim, Marine and Coastal Research Laboratory – DOE's marine lab

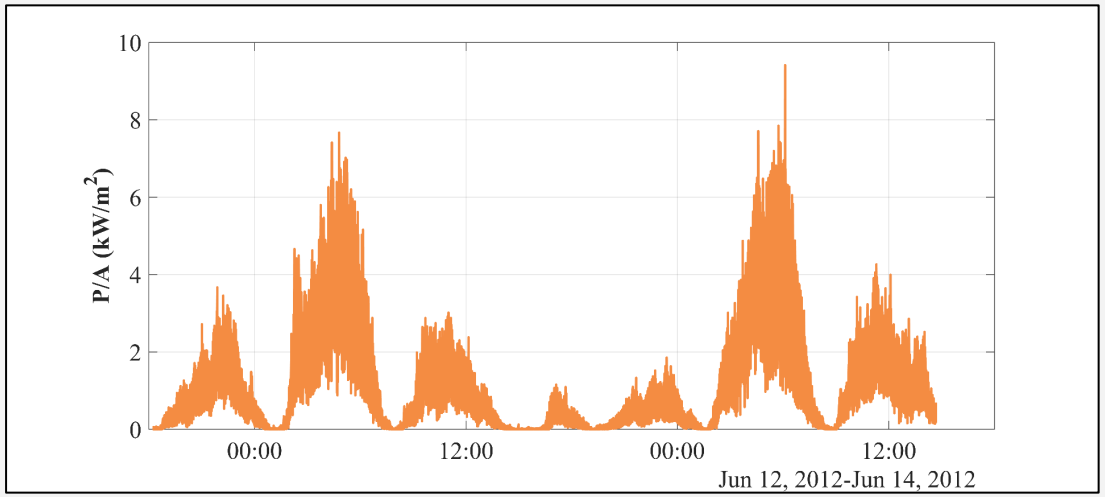
Marine Energy for Use at Sea and for Resilient Coastal Communities: Powering the Blue Economy

- DOE WPTO focus on wave, current, and gradient energy for markets and applications other than utility grid
  - Projects supported at labs, universities, and in industry
  - Opportunities for marine energy where other renewables are impossible or impractical or otherwise offers a unique value proposition
  - **PNNL** analyzed electrochemical pathways for **hydrogen and hydrogen carrier fuels from seawater** using marine energy through short-duration "seedling" projects

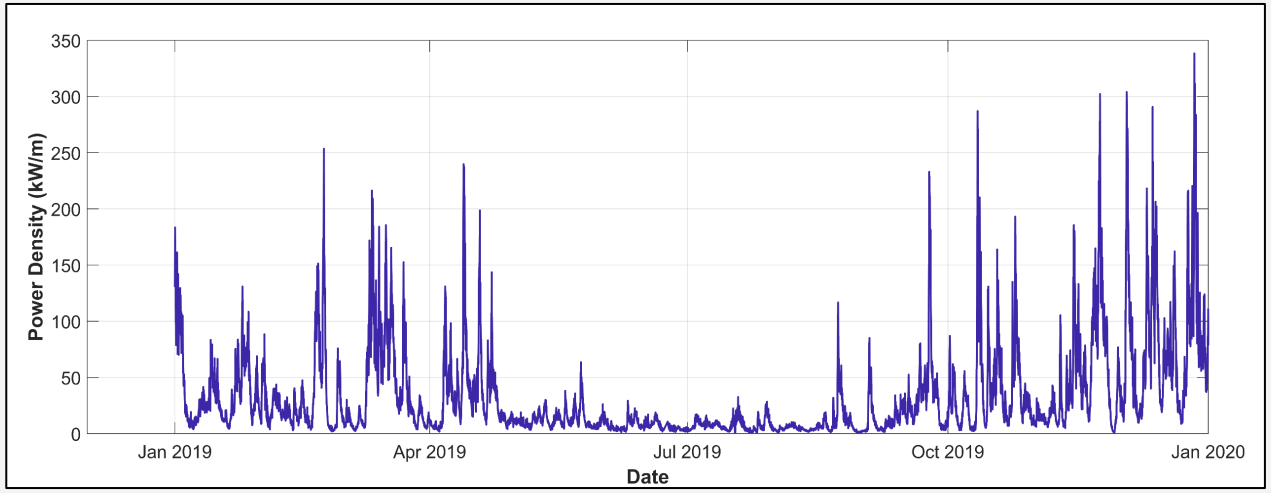


Electrochemical Storage for Marine Energy

- **Benefits:** direct energy use at sea, buffers intermittency, and generates fuels for maritime decarbonization



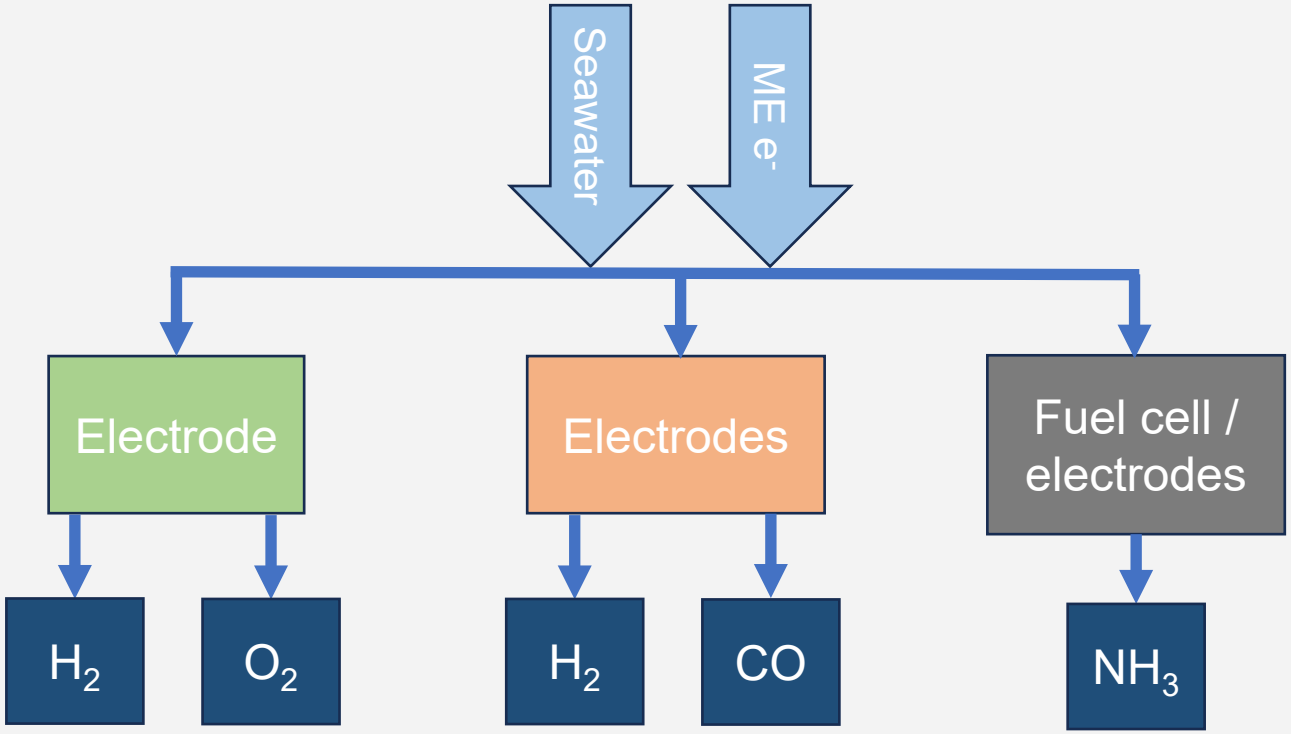
Tidal power near Admiralty Inlet, WA
(Data source: University of Washington)



Wave power near Sitka, AK
(Data source: NOAA National Data Buoy Center)

Pathways Explored

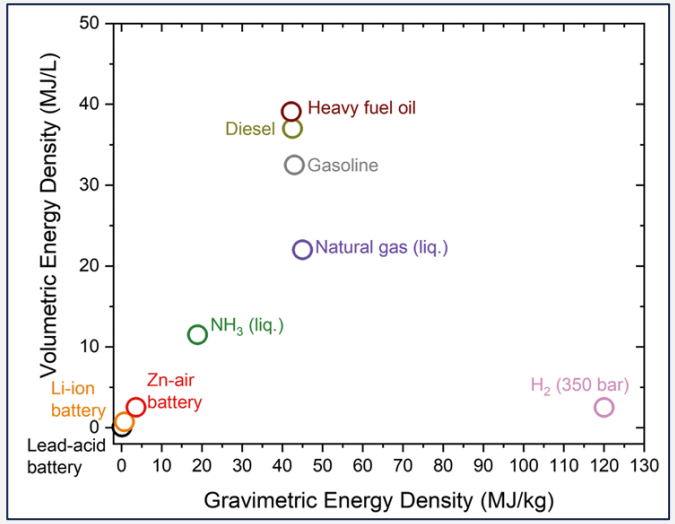
- Evaluating **feasibility**, **methodology**, and **efficiency**



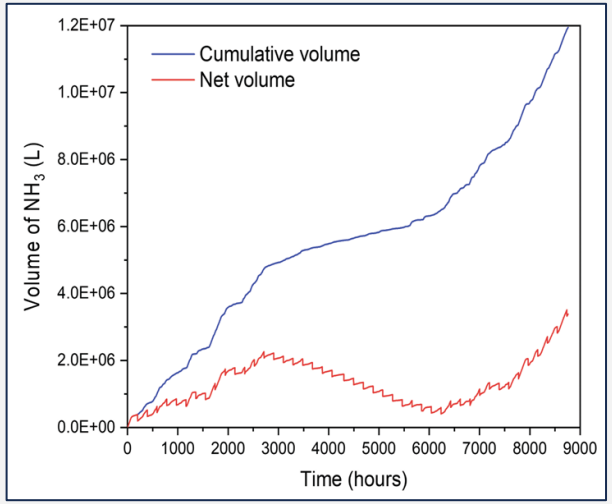
- Progress
  - Modeling and small-scale lab testing
  - Periodic/cyclic power may be a benefit
- Challenges
  - Cl evolution
  - Corrosion & degradation

Use Case: Wave Power to NH_3 for Ferry Fuel

- Ammonia is a candidate carbon-free fuel under consideration for maritime transportation use
- We modeled the efficiency from energy in waves to energy stored in ammonia
- We simulated a year of fuel use by a long-haul ferry from Bellingham, WA to Sitka AK
- We determined a 90 MW wave array outside of Sitka would be needed to generate enough fuel to continuously sustain this route



Energy densities of common storage mechanisms



Simulated fuel production and use from waves to NH_3-powered ferry

Liu, J., Cavagnaro, R. J., Deng, Z. D., Shao, Y., Kuo, L. J., Nguyen, M. T., & Glezakou, V. (2020). Renewable Ammonia as an Energy Fuel for Ocean Exploration and Transportation. Marine Technology Society Journal, 54(6), 126-136.

Pacific Northwest
NATIONAL LABORATORY

Contact Us!

robert.cavagnaro@pnnl.gov

WPW

NHA
National Hydropower Association

WATER.POWER.WEEK.
WASHINGTON, D.C. • MARCH 13-15, 2024
CAPITAL HILTON • WATERPOWERWEEK.COM