Public Marine Energy Data creation at the Atlantic Marine Energy Center (AMEC)

@OREC

Portland, Oregon, May 2024

Atlantic Marine Energy Center

Advancing the
Marine Renewable Energy Industry
and Powering the Blue Economy

DOE Award DE-EE0009450

Martin Wosnik
Atlantic Marine Energy Center
University of New Hampshire

Acknowledgement & Disclaimer

Acknowledgment: "This material is based upon work supported by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) under the Water Power Technologies Office (WPTO) Award Number DE-EE0009450."

Abridged Disclaimer: "The views expressed herein do not necessarily represent the views of the U.S. Department of Energy or the United States Government."

Outline

- Overview of AMEC
- Types of Public Marine Energy Data generated by AMEC
- Overview of test sites developed under AMEC
  - Scaled Tidal Energy Test Site at UNH
  - Scaled Wave Energy Test Site at CSI
- Two examples of Public Marine Energy Data created by AMEC
- Two (related) examples of coming data.
- General discussion on creating/collecting Public Marine Energy Data

Atlantic Marine Energy Center (AMEC)

Advancing the Marine Energy Industry and Powering the Blue Economy

AMEC is a National Marine Energy Center, sponsored by the U.S. Department of Energy

$10M grant, 4-year work scope, DOE WPTO (competitively awarded under FOA 2234)

Partner universities:

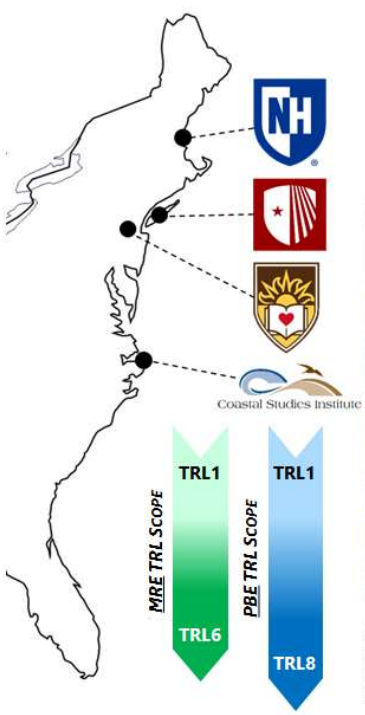
- University of New Hampshire (lead)
- Stony Brook University
- Lehigh University
- Coastal Studies Institute (North Carolina)

National Lab partners:

- National Renewable Energy Laboratory
- Pacific Northwest National Laboratory
- Sandia National Laboratories

International partner:

- European Marine Energy Center (EMEC)



Partners

Pacific Northwest NATIONAL LABORATORY

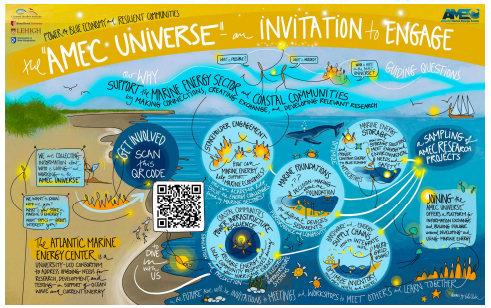
Sandia National Laboratories

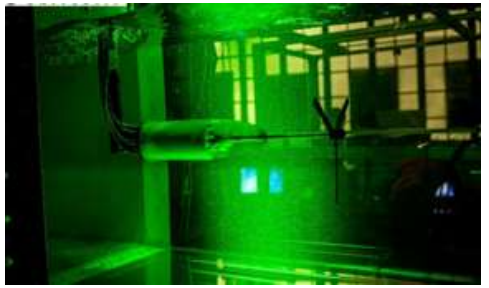
NREL NATIONAL RENEWABLE ENERGY LABORATORY

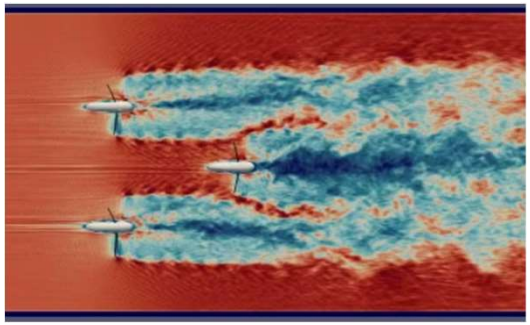
EMEC THE EUROPEAN MARINE ENERGY CENTRE LTD

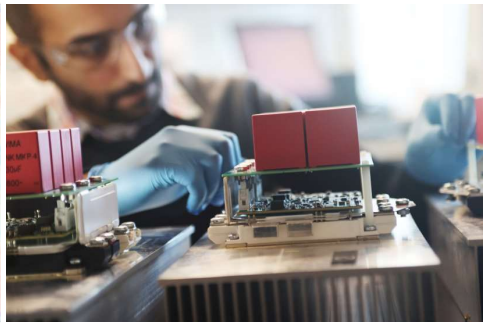
Creating/collecting Public Marine Energy Data at AMEC:

- **Stakeholder engagement**
- **Open water test facilities**
  - UNH: Scaled tidal energy test site (+ additional ocean test sites)
  - CSI: Scaled wave energy test site (+ additional ocean test sites)
- **Laboratory testing**
  - Lab-scale marine energy test beds (tidal, wave)
  - Microgrid test beds
  - Blade testing
  - Foundation testing
- **Numerical capabilities**
  - High-fidelity CFD
  - Ocean modeling
  - Digital Twinning



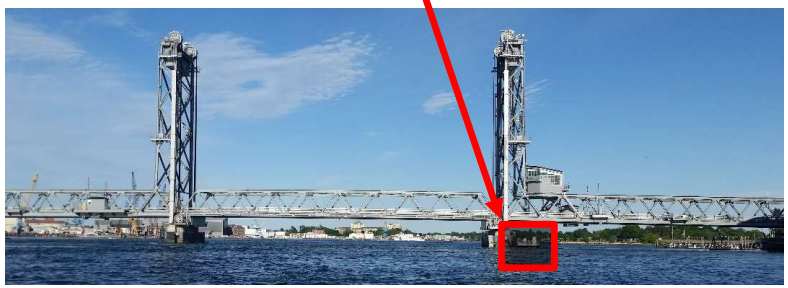






Tidal Energy Test Site at Memorial Bridge, Portsmouth, NH

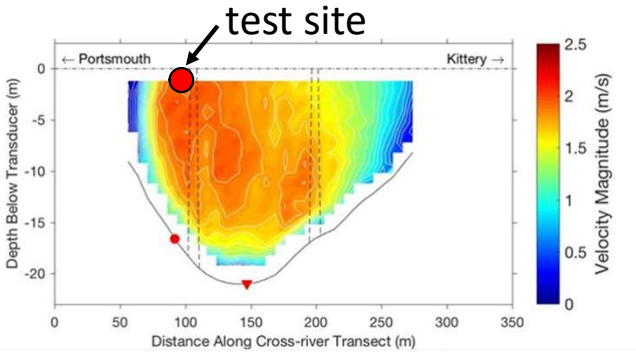
Atlantic Marine Energy Center



June 2018 - present

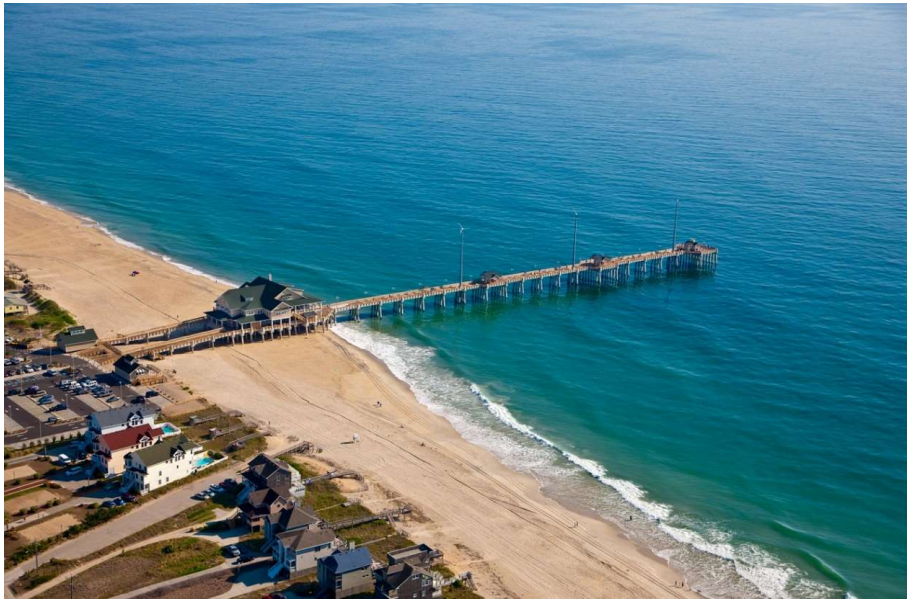
- Tidal Energy Test and Demonstration Site
- Deployment off 15m x 6m floating test platform, turbines up to D~3m (cross flow/axial flow)
- Maximum currents >2.5 m/s during ebb tide
- Nominal depth ~18m, tidal range ~3.7m, platform attached to bridge pier via vertical guide posts
- ***grid-connected, easy access***

DOE Open-Source Tidal Energy Converter (OSTEC) Test Bed



(spring ebb, 42 minute average)

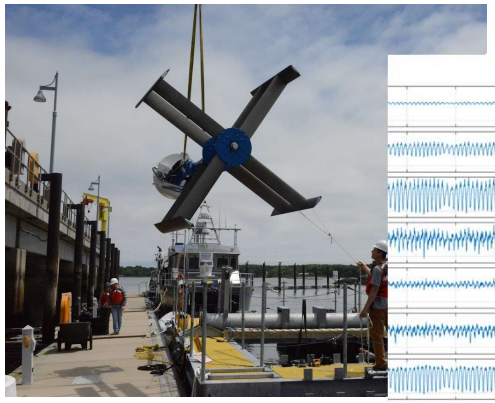
CSI Scaled Wave Energy Test Site, Jennette's Pier NC

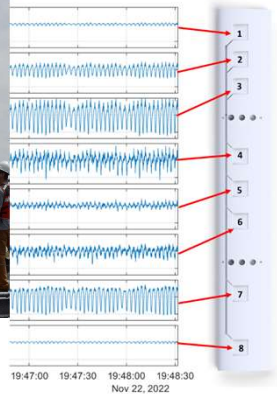


- Shallow Water Wave Energy Test Berths (Nearshore & Offshore)
- Allow for experiments on and observation and monitoring of the impacts of devices on the surrounding environment
- DOE Waves-to-Water Prize
- *Up to MRE TRL 6*

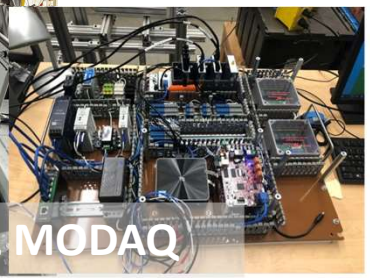
Performance and Loads Measurements at Tidal Energy Test Site

UNH & NREL: P. O'Byrne, M. Bichanich, M. Wosnik, A. Bharath, C. Nichols, H. Ross et al.

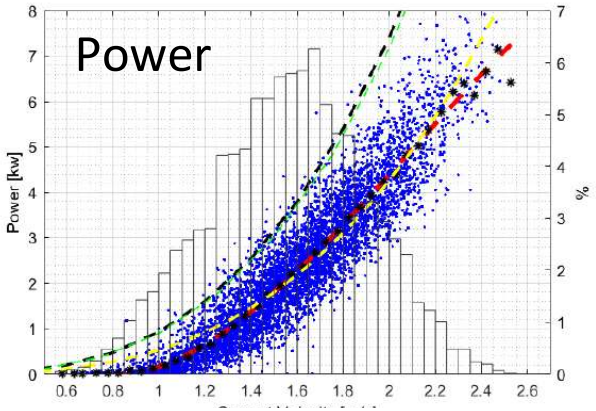


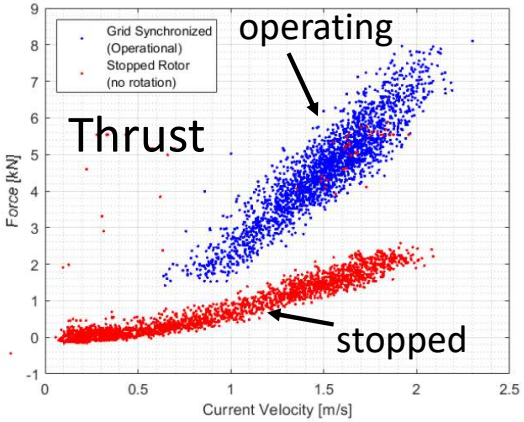


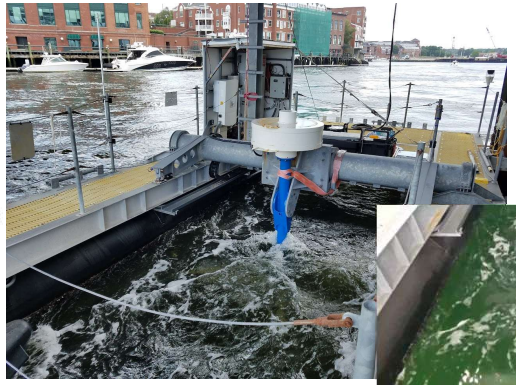
in-situ blade strain



UNH-NREL MODAQ







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Performance and Loads Measurements at Tidal Energy Test Site

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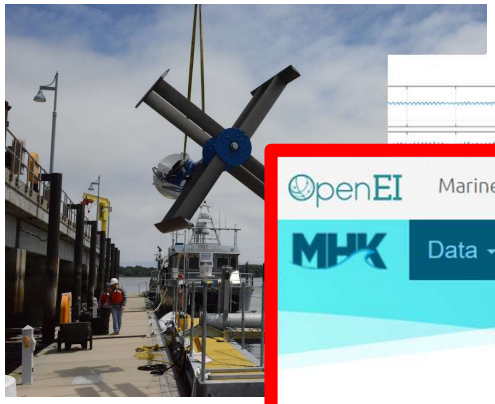
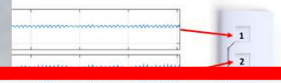
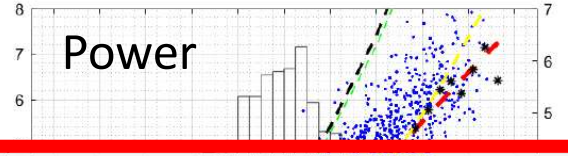




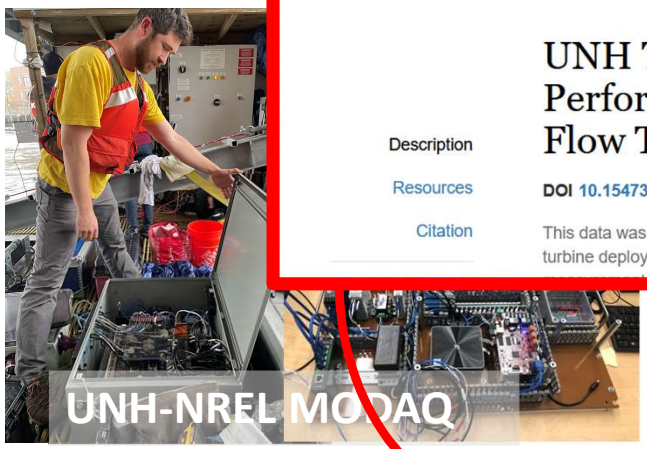


MHKDR

OpenEI Marine and Hydrokinetic Data Repository

MHK Data Help About Search

https://mhkdr.openei.org/submissions/394



Description

Resources

Citation

UNH TDP - Concurrent Measurements of Inflow, Power Performance, and Loads for a Grid-Synchronized Vertical Axis Cross-Flow Turbine Operating in a Tidal Estuary

DOI 10.15473/1973860

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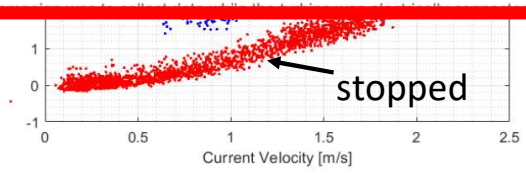
This data was collected between October 12 and December 15 of 2021 at the University of New Hampshire (UNH) and Atlantic Marine Energy Center (AMEC) turbine deployment platform (TDP). This data set includes over 29 days of grid connected turbine operation during this 65 day time frame. The priority for this



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text files with metadata for each instrument

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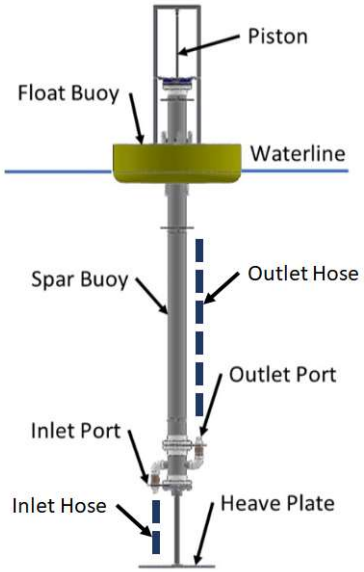
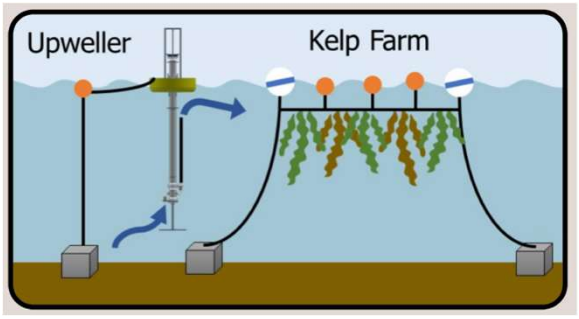
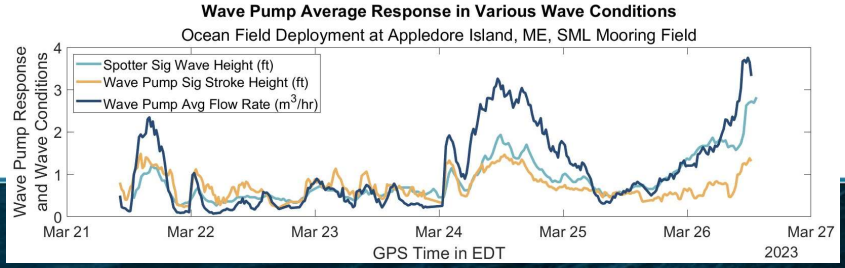
UNH Wave Powered Water Pump

C. Kimball, M. Wosnik, R. Swift

- A “Powering the Blue Economy” application
- Use wave energy to upwell cold, nutrient rich water to the photic zone where kelp is grown
- Designed to increase productivity of macroalgae
- Modeling (WEC-Sim), Tank Testing, Ocean Test for model validation







Ocean Test at Isles of Shoals

(@ Shoals Marine Lab)

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UNH Wave Powered Water Pump

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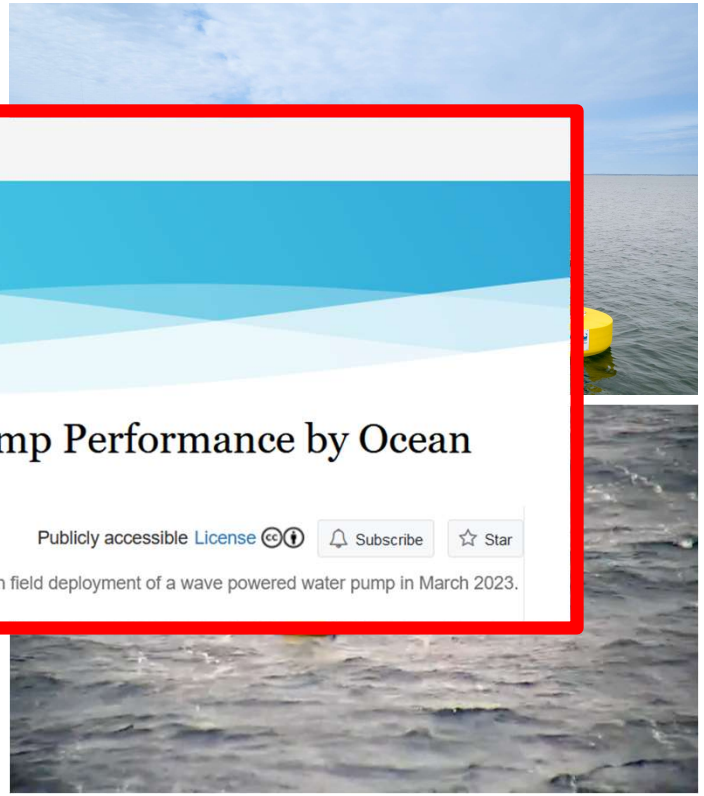

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Evaluation of a Wave Powered Water Pump Performance by Ocean Field Testing and WEC-Sim Modeling

Description

Resources

DOI 10.15473/2000556

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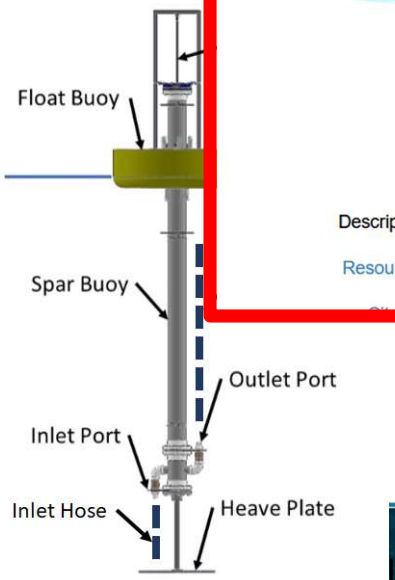
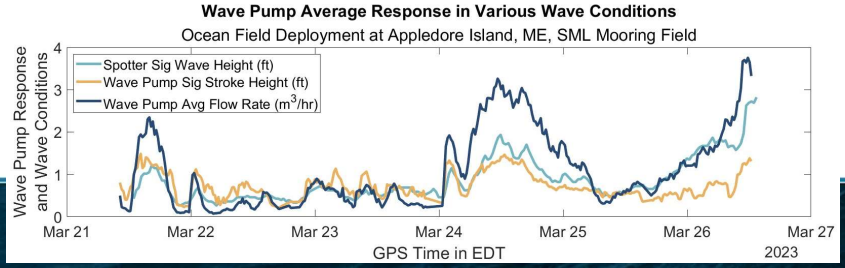
This submission from AMEC (the Atlantic Marine Energy Center) includes data from an ocean field deployment of a wave powered water pump in March 2023. The wave pump is an upweller device, designed to enhance macroalgal aquaculture.





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Open-Source Tidal Energy Converter (OSTEC)

V.S. Neary (SNL), M. Wosnik (AMEC-UNH), R. Cavagnaro (PNNL), A. Bharath (NREL) et al.

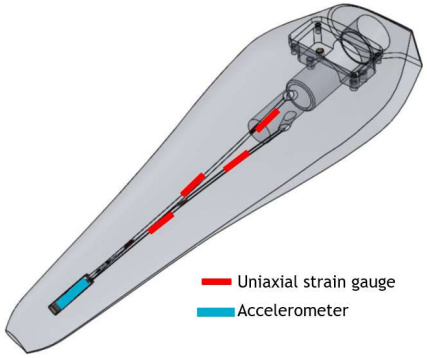
- **instrumented reference turbine, test bed for R&D and data generation in real open-water tidal flow conditions**
- **3-bladed axial-flow turbine, D=2.5m**
  - **allows Reynolds number independence, and**
  - **upscaling of material and component, load response and stress-strain behavior, fluid-structure-interactions.**
  - **Initial blades: MHK-F1**
- **deployed from 15 m x 6 m Turbine Deployment Platform at the UNH-AMEC Tidal Energy Test Site.**
- **enables testing, demonstration, and improvement of recommended best practices in international standards, including the IEC's technical specifications on marine energy converters (TC 114)**

OSTEC Testbed for Marine Energy R&D

Short list of studies enabled by this test bed --- some of these can be concurrent

- **Blade R&D (geometries, materials, coatings, sensors)**
- **Blade failure modes R&D (pitch misalignment, damaged blades, missing blade, etc.)**
- **Health monitoring R&D (systems for sensing failure onsets, e.g., blades)**

"modularity -- within reason": Some parts can readily be exchanged – e.g., blades – while other sections or assemblies can be adapted and replaced if needed.



- **Model V&V (TurbSim, OpenFAST, CFD & FSI)**
- **Advanced controls research utilizing rotor speed or torque regulation**
- **Debris detection and mitigation using acoustic imaging and turbine control**
- **Concurrent environmental studies**
- **Turbine wake studies**
- **Gearbox lubricant research**
- **corrosion protection, biofouling mitigation**
- **Process monitoring using dedicated sensors or generator output analysis**
- **Novel power electronics development**
- **IO&M process studies**
- **CapEx, OpEx, LCOE benchmarking studies**

Axial Flow Turbine Test Bed

S. Pamboukes, M. Andersen, M. Wosnik

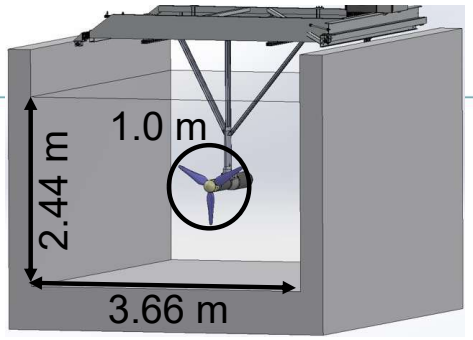
A “reference model for the reference model”

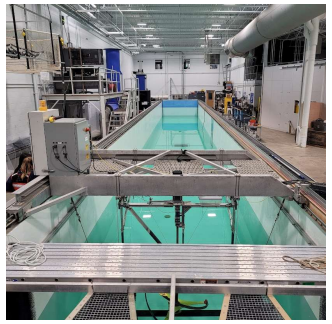
1.0-m scale test bed (standalone rotors or new blades attached to generic hub)

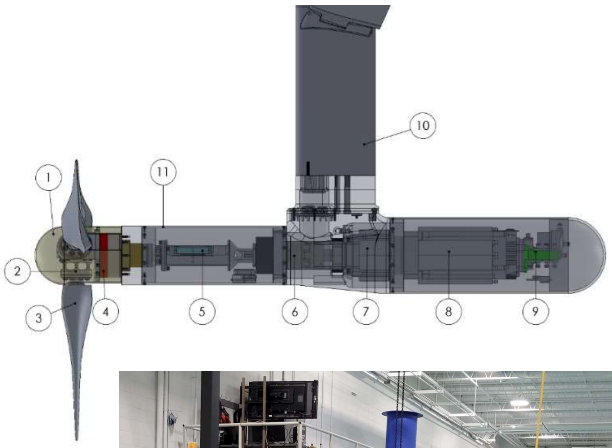
- Reynolds number independence
- Blockage ratio < 10%

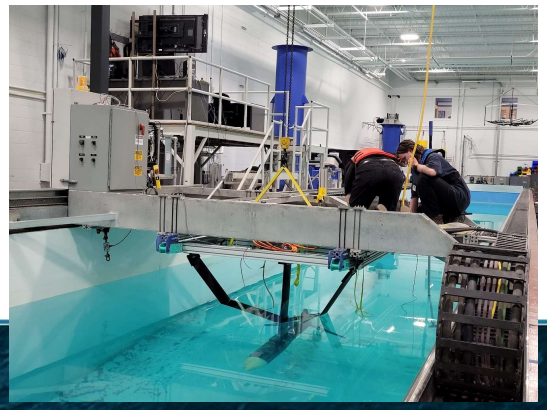
- Sealed nacelle w/ geared servo-generator
- **Torque, thrust, blade root bending moments (flapwise / edgewise)**
- Enhanced testing capabilities for **TEAMER**
- Design aligned with **IEC TS 62600-202**

For TSR = 4.5 @ r/R = 0.7:
$Re_c \approx 240{,}000 - 480{,}000$ for $U_{tow} = 1.0 - 2.0$ m/s









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Creating/collecting Public Marine Energy Data at AMEC:

- **AMEC to date: 12 public project data sets on MHKDR** OpenEI Marine and Hydrokinetic Data Repository
- **Also: many legacy data sets, including reference model experimental and numerical data on**
  - GitHub
  - Figshare

- **WE HAVE LOTS and LOTS OF DATA COMING!**

- **Fundamental discussion and convergence needed on:**
  - What data is most useful for the Marine Energy field in general? What is needed for model V&V?
  - QA / QC, data collection, processing (what to store), standardized analysis tools, incl. uncertainty
  - Detailed metadata for all experiments and deployments
  - Data longevity / persistence (how will we access this data 10, 20, 30 years from now?)

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University of New Hampshire

LEHIGH UNIVERSITY

Stony Brook University

Coastal Studies Institute
A Multi-Institutional Research Partnership

new AMEC video!

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@LU: Arindam Banerjee, Shalinee Kishore
@SBU: Ali Khosronejad, Fang Luo