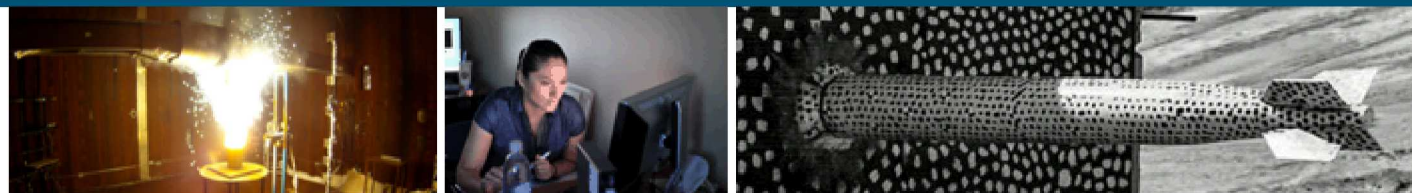


Overview of the Marine & Hydrokinetic Advanced Materials Program



PRESENTED BY

Bernadette A. Hernandez-Sanchez*, Budi Gunawan,
George Bonheyo, David Miller, Scott Hughes, Francisco
Presuel-Moreno

Water Power Technologies Office within the U.S. Department of Energy's Office of Energy
Efficiency and Renewable Energy (EERE)"

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Thank You for submitting samples (FY17-18) program!

**Listed in alphabetical order*

Composite Coupons & Coatings Provided by:

Composites Engineering Research Laboratory

Composites Technology Development, Inc.

Hygrateck

Janicki Industries

Ocean Renewable Power Company

Polyone

Verdant Power

We have a multidisciplinary team dedicated to addressing material & coatings needs.

Sandia National Laboratories

- Bernadette A. Hernandez-Sanchez: (PI) Materials Chemistry
- Budi Gunawan: Loads & FBG Sensors



Pacific Northwest National Laboratory

- George Bonheyo (WSU): Biofouling



Washington State
University

National Renewable Energy Laboratory

- Scott Hughes: Substructure Testing



Montana State University

- David Miller: Composite Performance



Florida Atlantic University

- Francisco Presuel-Moreno: Corrosion



Webinar Agenda (Times listed in EDT)

Time	Topic & Presenter
10:00 am	Welcome & Introduction (Lauren Moraski)
10:10 am	Overview of the MHK Materials Program (Bernadette Hernandez-Sanchez)
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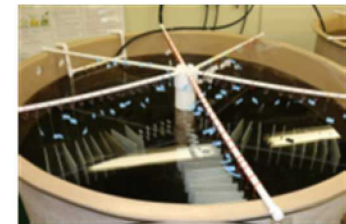
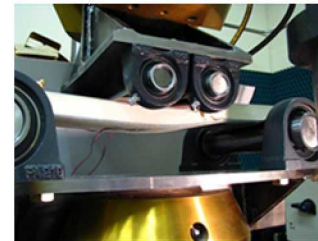


Program Overview

Marine and Hydrokinetics Advanced Materials Program: support the MHK industry through applied research and guidance on Materials & Coatings to enable viability, lower the cost of energy (COE), and accelerate commercialization.

The Challenge: Proper structural/component materials and coatings are critical to reducing engineering barriers, COE, and commercialization time

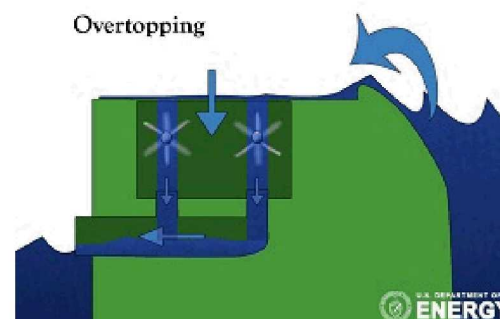
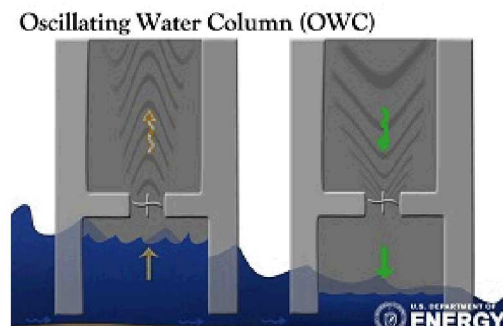
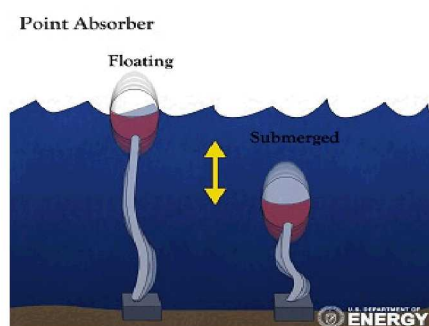
- **Structure Design & Component: (LOADS! uncertainty in composite/design)**
- **Environmental Exposure Issues**
- **Cost (Manufacture, O&M, Reliability)**
- **Safety & Certification**



Current Program Objective: **Helping MHK industry reduce uncertainty in using composites in their designs.**

- Direction taken from 2015 Workshop on Composite Needs for MHK.
- Past efforts involved determining materials needs for industry, examining coatings for biofouling, and examining marine effects on wind based composites.

Why investigate fiber reinforced composites?



- **Areas of concern vary by design:** metals, hydraulic fluids, polymers, cement, magnetic, coatings, composites
- **Composites Include:** Reinforced rubbers, reinforced concrete, fiber reinforced plastics
- **Studies indicate impact to cost:** Reference Models (SNL, NREL); Wave Energy Scotland Structural Loads and Materials Landscape Study; and 2011 Carbon Trust report indicate the structure costs can be impacted by using light weight and non-corroding materials.

Materials can impact areas that affect commercialization.

- Structure costs
- Design & manufacture
- Accelerate manufacturing or direct advanced manufacturing strategies
 - We are working to reduce risk through testing of novel materials and materials validate for other marine-based industries under MHK conditions.
 - Future testing on materials under deployed conditions are needed for validation.
- Reliability & Survival
- Operation & Maintenance
- Certification & Safety

Helping the MHK industry with materials & protective coatings challenges



Courtesy of Resolute Marine Energy



<http://www.yachtsurvey.com/glassboats-1.jpg>



<http://www.racerocks.ca/>



ICIT & EMEC
<http://tidalenergytoday.com/2016/01/12/icit-emec-study-biofouling-of-marine-energy-technologies/>

Previous work conducted by program (FY12-16)

Biofouling & Marine coatings assessment



Structural Health Monitoring

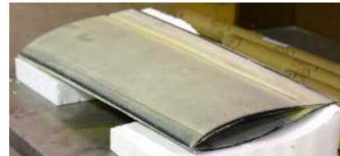


Figure 2 – Section of an ORPC-supplied fuel hose which coupon substrates were cut.



Figure 3 – Cross section of the ORPC-supplied fuel hose showing the laminate layer.



Figure 4 – Test specimen with a mounted MDI bare FBG sensor.

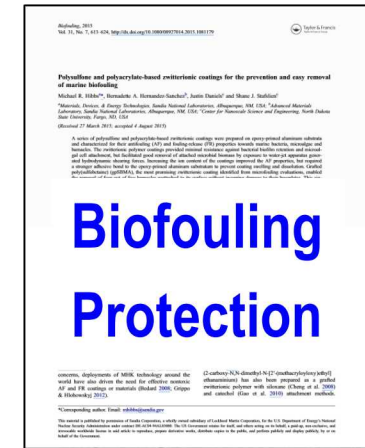
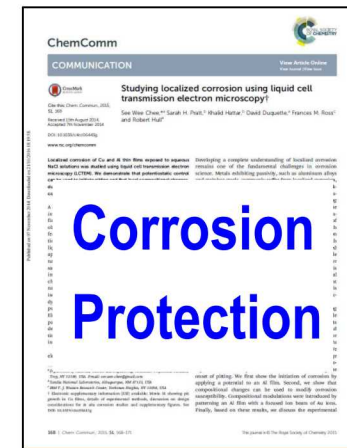
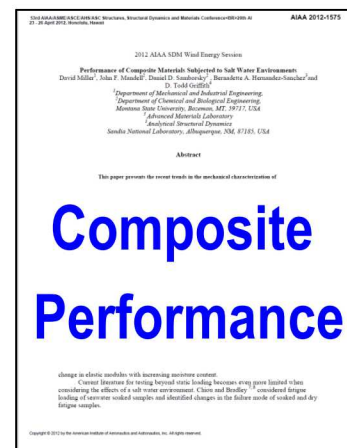
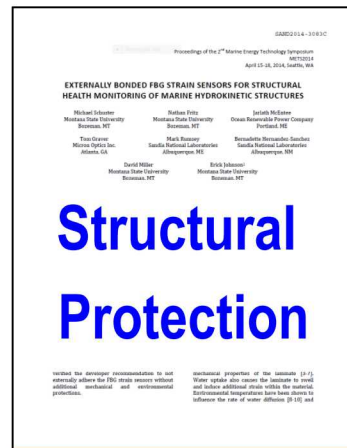
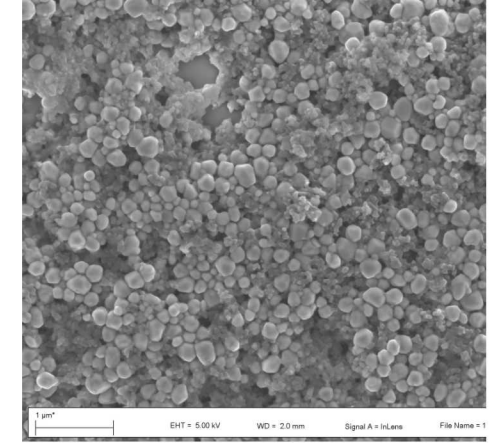


Figure 5 – Test specimen with a mounted MDI standard package FBG sensor.

MHK Environmental Effects on Composites



Nanomaterials Development



Our current program's goal is to address barriers & uncertainty in using composite materials for MHK.

Material Design Tools for Marine and Hydrokinetic Composite Structures

Objective: Helping MHK industry reduce uncertainty in using composites in their designs

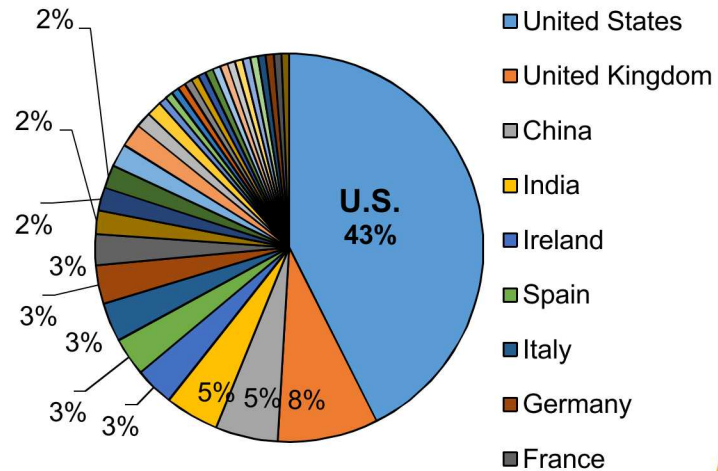
- Providing an *industry approved* U.S. DOE MHK Composite Materials & Structures Database (*open resource*): <http://energy.sandia.gov/energy/renewable-energy/water-power/technology-development/advanced-materials/mhk-materials-database/>
- Mitigating composite biofouling/environmental effects & metal-carbon fiber interconnect corrosion in saltwater
- Examining MHK load challenges on composite material & substructure performance to improve design



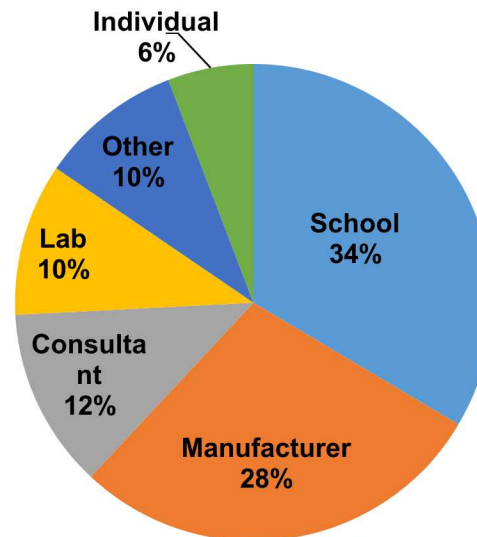
The MHK Composite Materials & Structures Database was born from materials discovery in wind energy.

U.S. DOE MHK Composite Materials & Structures Database:
Benefits: Open Source, Industry Advised, Backed with Publications.

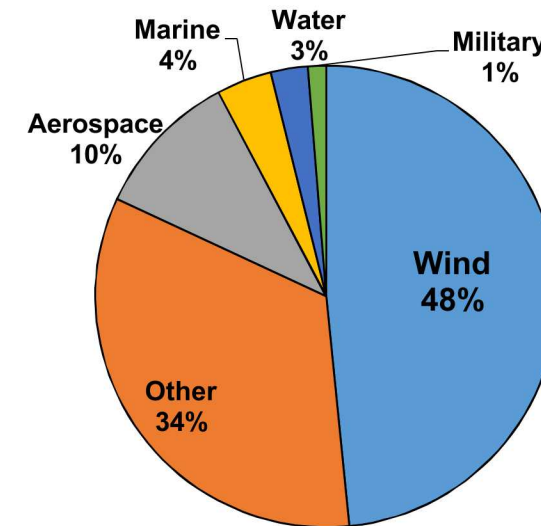
Country



User Type



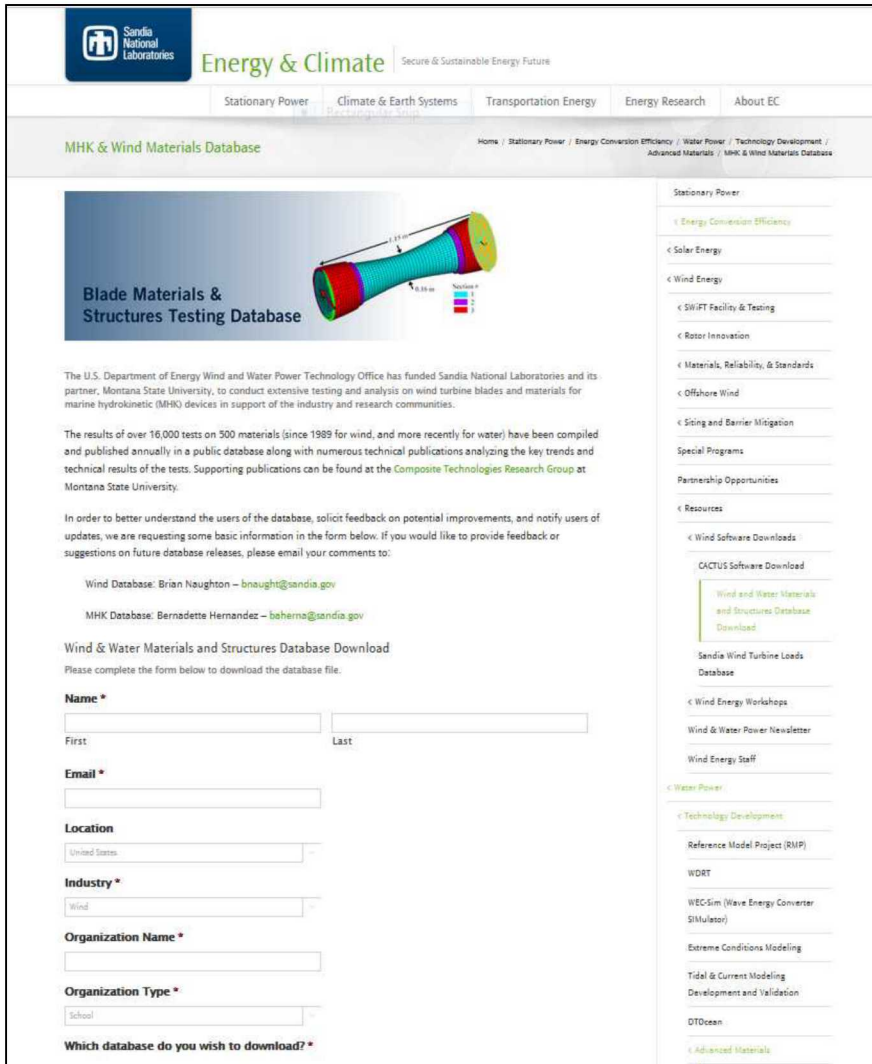
Institution



- <http://energy.sandia.gov/energy/renewable-energy/water-power/technology-development/advanced-materials/mhk-materials-database/>

Current User Community of U.S. DOE Materials & Structures Database

Database can be found in 2 locations online and is free for users to download.



Sandia National Laboratories Energy & Climate Secure & Sustainable Energy Future

Stationary Power Climate & Earth Systems Transportation Energy Energy Research About EC

MHK & Wind Materials Database

Blade Materials & Structures Testing Database

The U.S. Department of Energy Wind and Water Power Technology Office has funded Sandia National Laboratories and its partner, Montana State University, to conduct extensive testing and analysis on wind turbine blades and materials for marine hydrokinetic (MHK) devices in support of the industry and research communities.

The results of over 16,000 tests on 500 materials (since 1989 for wind, and more recently for water) have been compiled and published annually in a public database along with numerous technical publications analyzing the key trends and technical results of the tests. Supporting publications can be found at the [Composite Technologies Research Group](#) at Montana State University.

In order to better understand the users of the database, solicit feedback on potential improvements, and notify users of updates, we are requesting some basic information in the form below. If you would like to provide feedback or suggestions on future database releases, please email your comments to:

Wind Database: Brian Naughton – bnaught@sandia.gov

MHK Database: Bernadette Hernandez – baherna@sandia.gov

Wind & Water Materials and Structures Database Download

Please complete the form below to download the database file.

Name *

First Last

Email *

Location

United States

Industry *

Wind

Organization Name *

Organization Type *

School

Which database do you wish to download? *

Stationary Power

Energy Conversion Efficiency

Solar Energy

Wind Energy

SWIFT Facility & Testing

Rotor Innovation

Materials, Reliability, & Standards

Offshore Wind

Siting and Barrier Mitigation

Special Programs

Partnership Opportunities

Resources

Wind Software Downloads

CACTUS Software Download

Wind and Water Materials and Structures Database Download

Sandia Wind Turbine Loads Database

Wind Energy Workshops

Wind & Water Power Newsletter

Wind Energy Staff

Water Power

Technology Development

Reference Model Project (RMP)

WDRT

WEC-Sim (Wave Energy Converter Simulator)

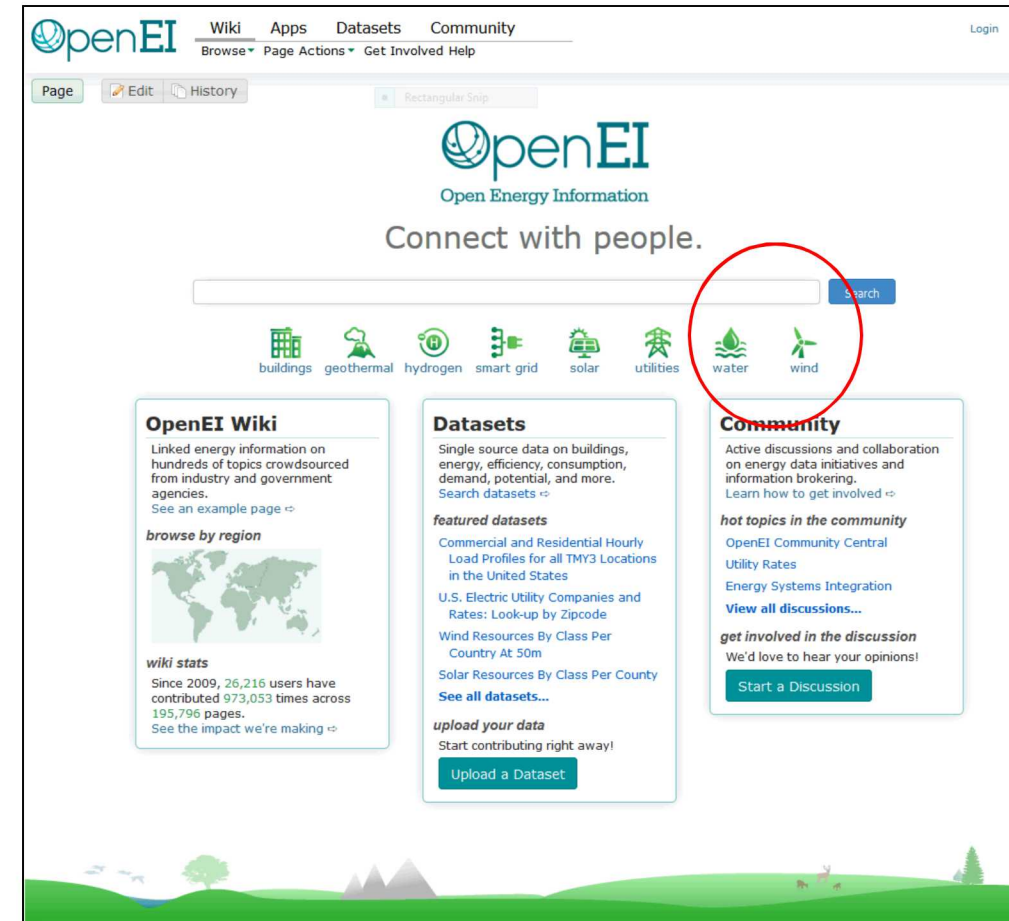
Extreme Conditions Modeling

Tidal & Current Modeling Development and Validation

DTOcean

Advanced Materials

<http://energy.sandia.gov/energy/renewable-energy/water-power/technology-development/advanced-materials/mhk-materials-database/>

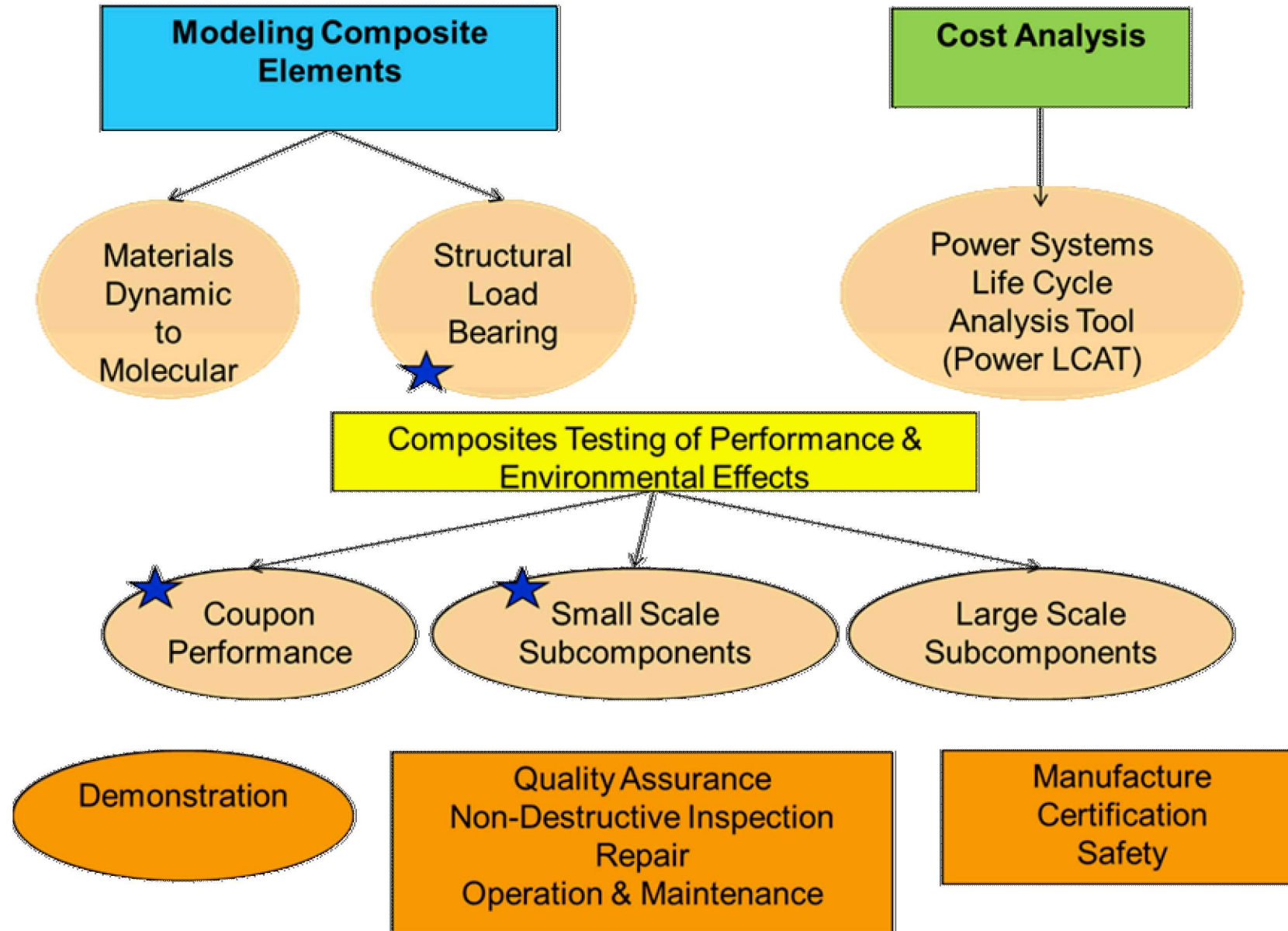


- Both the wind & water icons take you to webpages that house the link.
- Under Water Power Database and Tools
- PNNL has environmental effects database



<https://tethys.pnnl.gov/>

You will see the initiation of research for a larger vision needed to support composite development.



Summary of Current Activities and Future Directions

FY17



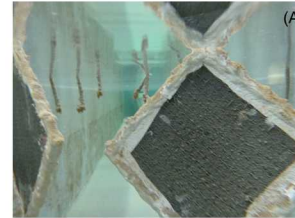
Salt Water Effects on Composite Performance Testing

Biofouling & Environmental Effects on Composites



FY18

Metal – Carbon Fiber Composite Interconnects in Seawater

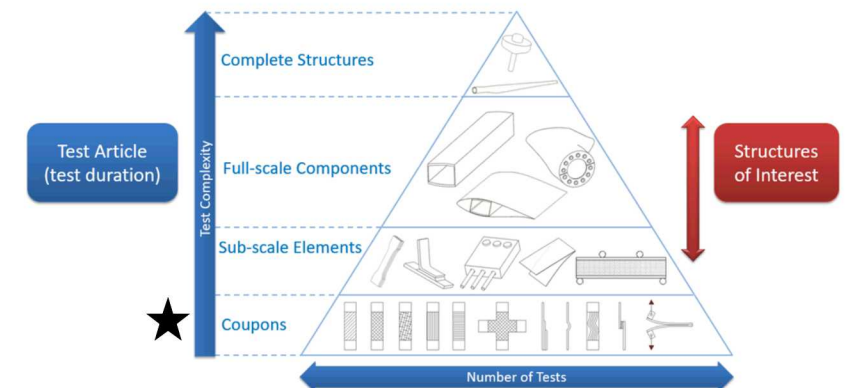


Industry directed sub scale elements & joined coupon fabrication/testing (Artificial & Actual Seawater)



FY19

Industry directed full scale subcomponent testing (Artificial & Actual Seawater)



You will hear what we have learned and what else we would like to know.

- Water absorption into composites impacts materials properties (composite performance, accelerated corrosion-carbon based)
- Not all antifouling coatings are created equal. MHK has its own conditions.
- What does the MHK industry needs for subcomponent testing?
- Corrosion: anode samples are corroding and calcareous deposits have formed on the interconnected composites.
- Load characterization and measurements testing are being conducted to advance our understanding of MHK conditions on composite materials.
- Results on samples from industry have been explored and will be downloaded to our database.
 - This public information is garnered to support design decisions.
- Future activities

Feedback and recommendations are more than welcome!

Bernadette Hernandez-Sanchez
Sandia National Laboratories
baherna@sandia.gov

or

Lauren Moraski
Water Power Technologies Office
Lauren.Moraski@ee.doe.gov

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Wrap up

- Thank you for listening and participating.
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