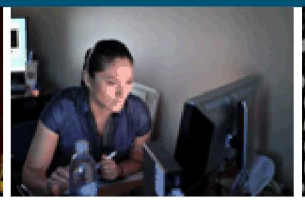
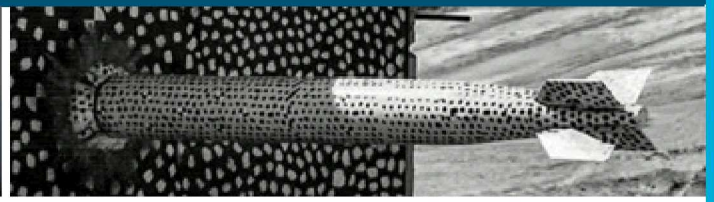
SAND2018-7478PE

Overview of the Marine & Hydrokinetic Advanced Materials Program

FAU FLORIDA ATLANTIC UNIVERSITY

MONTANA STATE UNIVERSITY

NREL NATIONAL RENEWABLE ENERGY LABORATORY

Pacific Northwest NATIONAL LABORATORY

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)
10:30 am	Biofouling Evaluation (George Bonheyo)
11:55 am	Composite Evaluation (David Miller)
11:20 am	Corrosion Evaluation (Francisco Presuel-Moreno)
11:45 am	Break
12:00 pm	Industry Survey on Subcomponent Needs (Scott Hughes)
12:25 pm	Loads Testing (Budi Gunawan)
12:50 pm	Wrap Up (B. Hernandez-Sanchez)



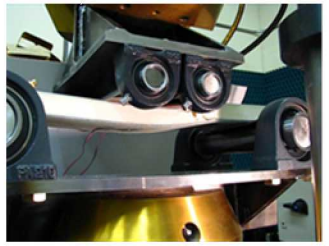


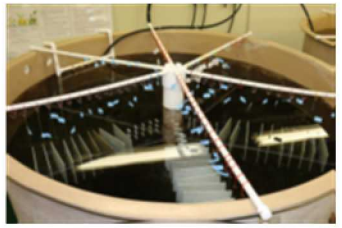

Program Overview

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**

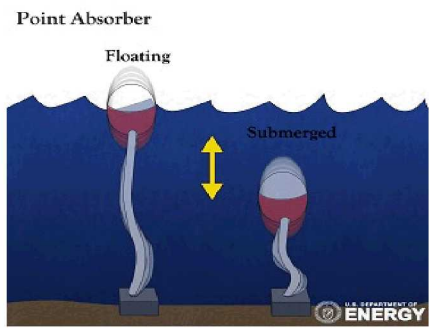


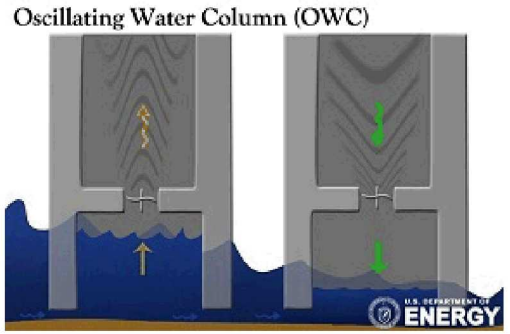


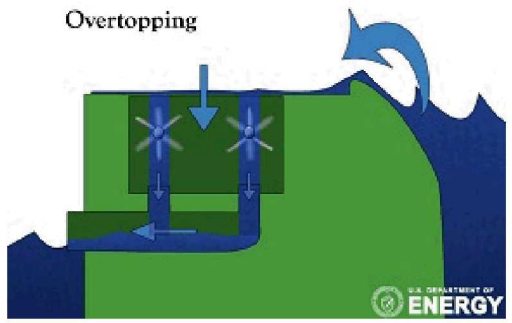
Current Program Objective: Helping MHK industry reduce uncertainty in using composites in their designs.

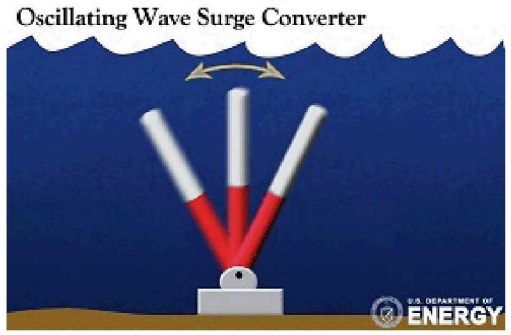
- Direction taken from 2015 Workshop on Composite Needs for MHK.
- Past efforts involved determining materials needs for industry, examining coatings for biofouling, and examining marine effects on wind based composites.

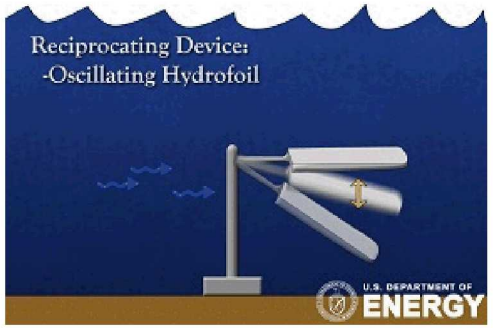
Why investigate fiber reinforced composites?

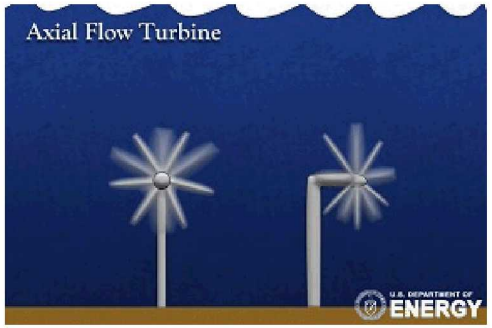












- **Areas of concern vary by design:** metals, hydraulic fluids, polymers, cement, magnetic, coatings, composites
- **Composites Include**: Reinforced rubbers, reinforced concrete, fiber reinforced plastics
- **Studies indicate impact to cost:** Reference Models (SNL, NREL); Wave Energy Scotland Structural 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

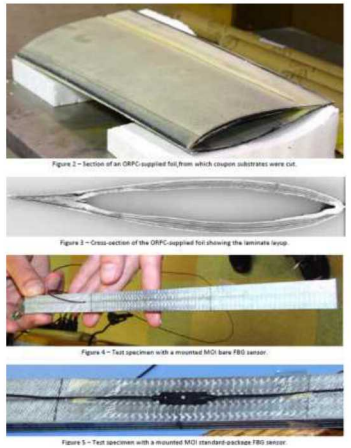
http://www.racerocks.ca/

http://tidalenergytoday.com/2016/01/12/icit-emec-study-biofouling-of-marine-energy-technologies/

Previous work conducted by program (FY12-16)

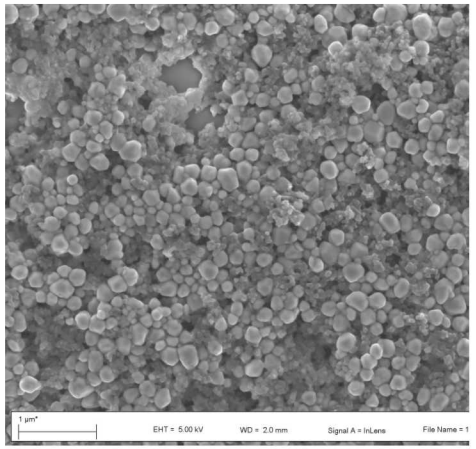
Biofouling & Marine coatings assessment

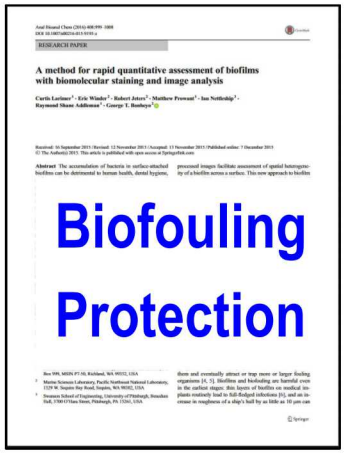
Structural Health Monitoring



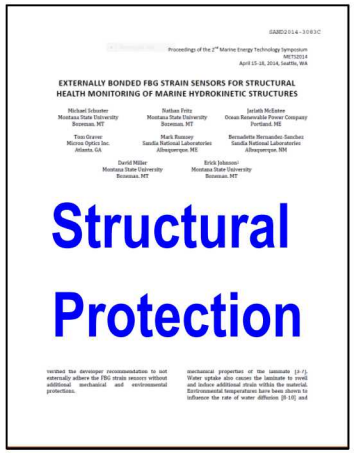
MHK Environmental Effects on Composites

Nanomaterials Development

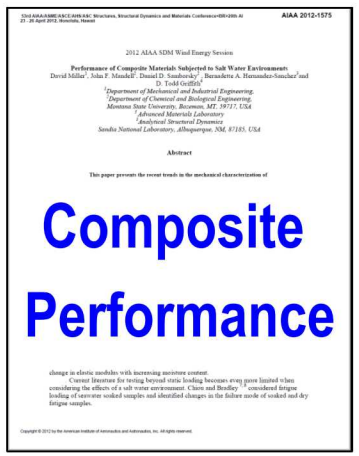




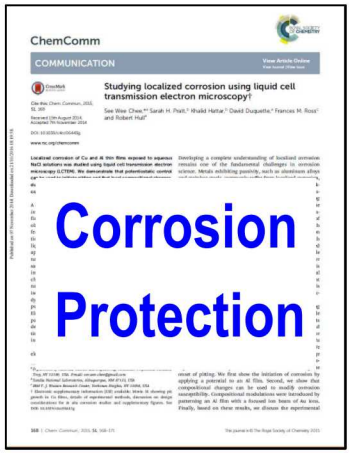
Biofouling Protection



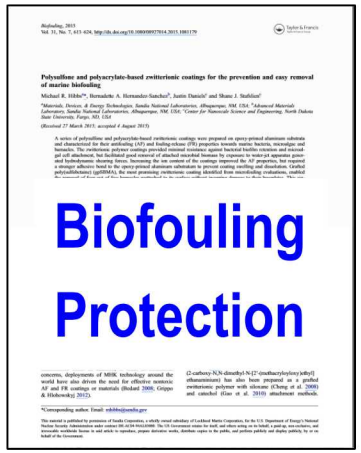
Structural Protection



Composite Performance



Corrosion Protection



Biofouling Protection

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

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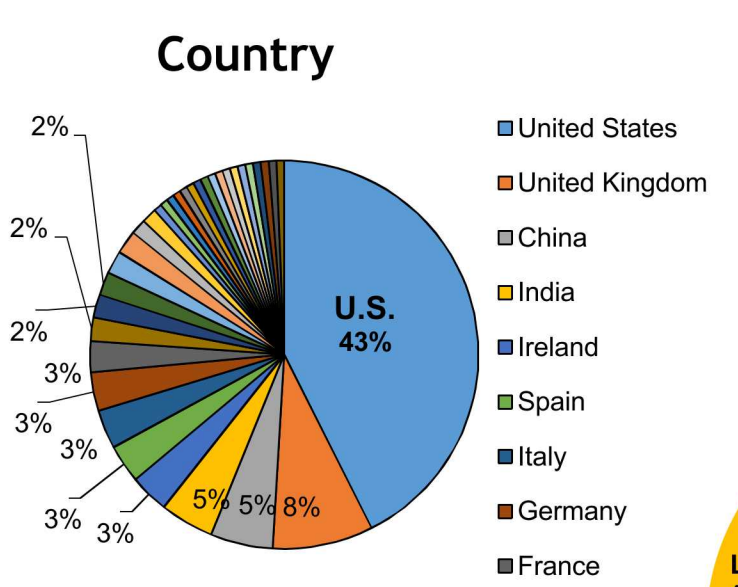
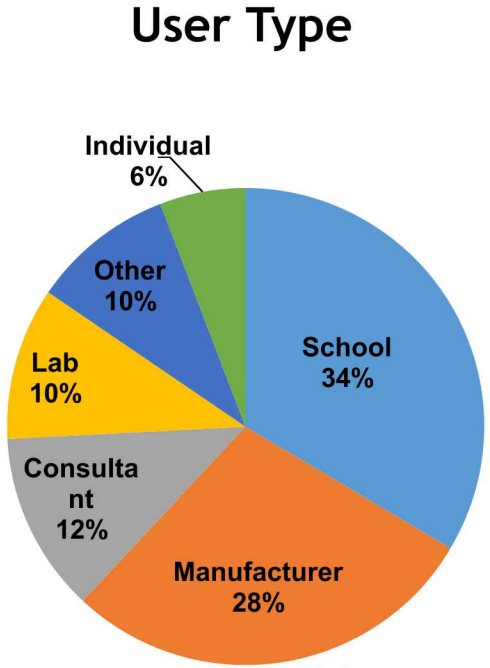
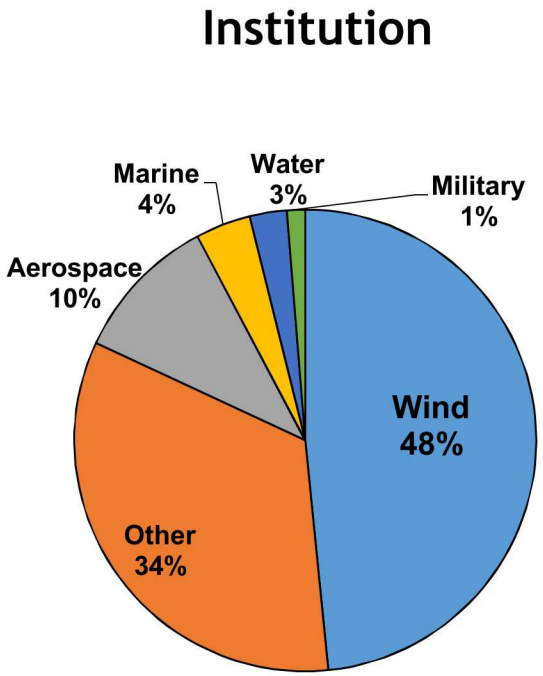
The MHK Composite Materials & Structures Database was born from materials discovery in wind energy.

U.S. DOE MHK Composite Materials & Structures Database:

Benefits: Open Source, Industry Advised, Backed with Publications.



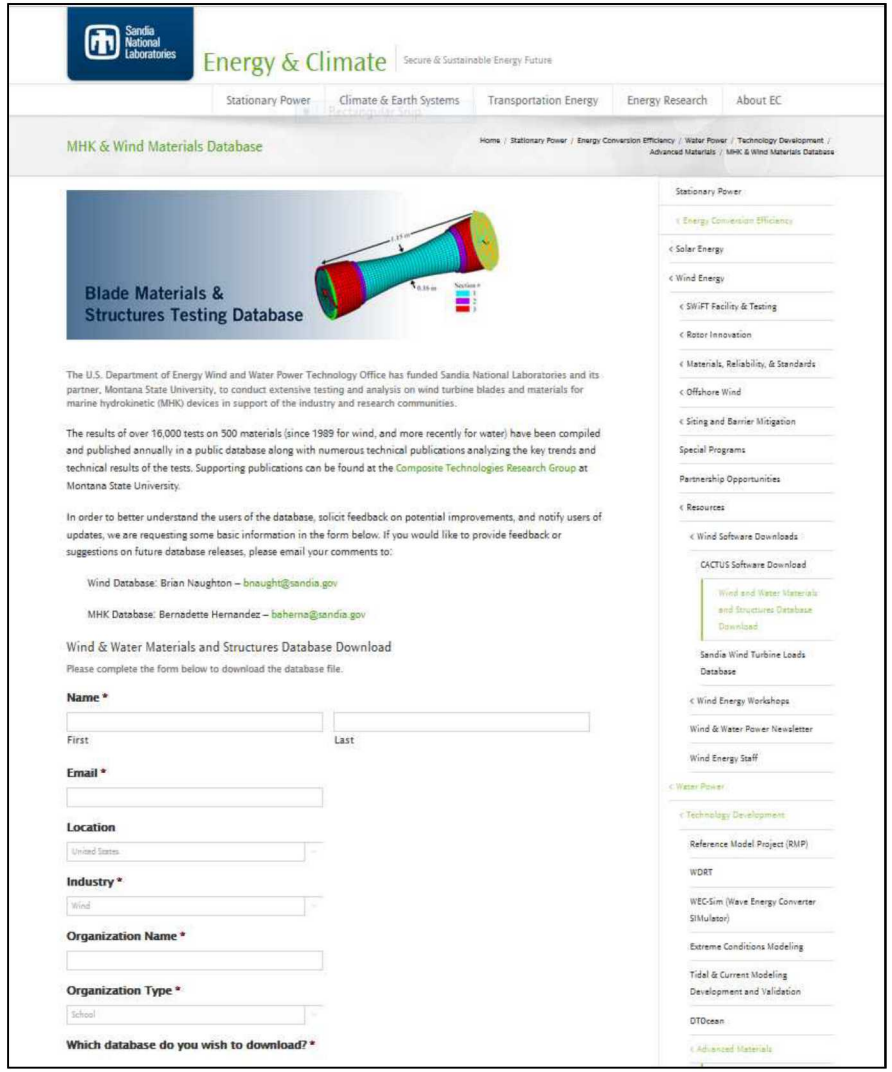




- http://energy.sandia.gov/energy/renewable-energy/water-power/technology-development/advanced-materials/mhk-materials-database/

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.

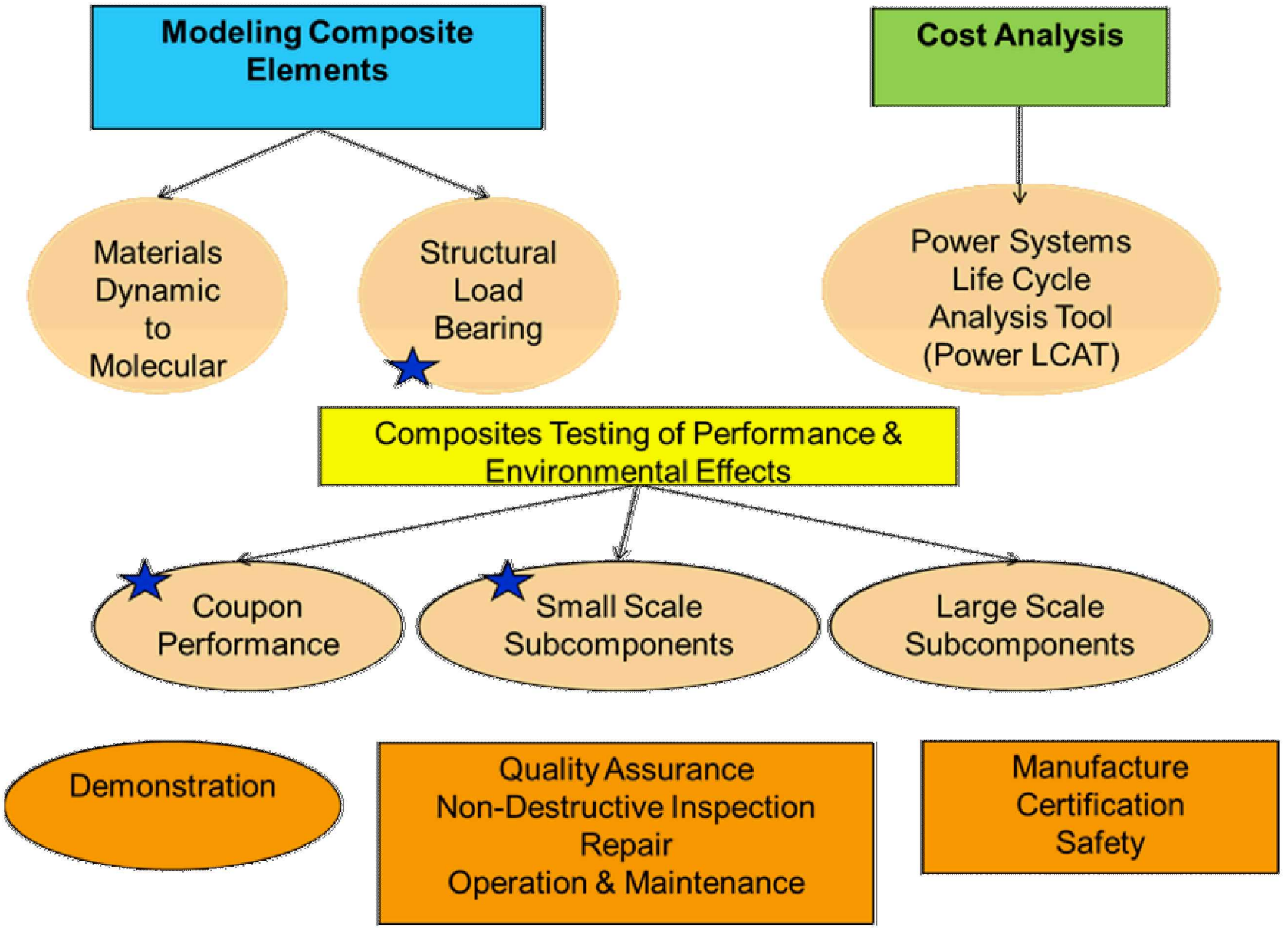


http://energy.sandia.gov/energy/renewable-energy/water-power/technology-development/advanced-materials/mhk-materials-database/

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

TETHYS
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

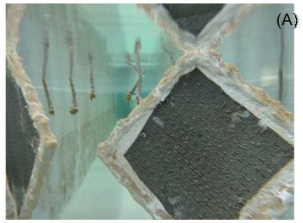
Biofouling & Environmental Effects on Composites

Coupons provided by:

- **Composites Engineering Research Laboratory,**
- **Composites Technology Development, Inc.**
- **Hygrateck**
- **Janicki Industries**
- **Ocean Renewable Power Company**
- **Polyone**
- **Verdant Power**

FY18

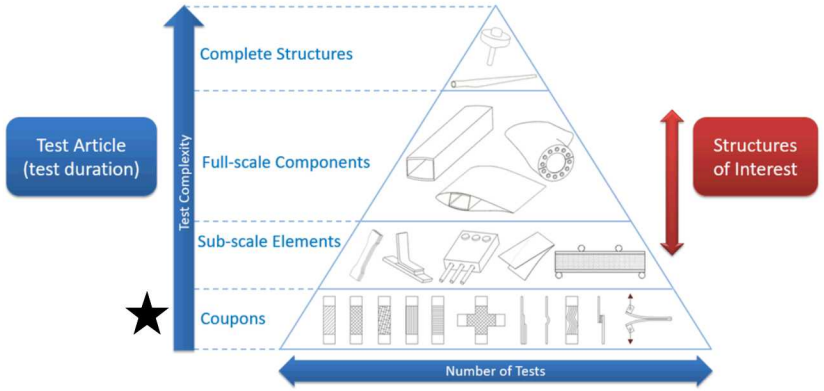
Metal – Carbon Fiber Composite Interconnects in Seawater



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 Participation

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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12:50 pm	Wrap Up (B. Hernandez-Sanchez)






Wrap up

- Thank you for listening and participating.
- Additional questions or comments can be sent to Lauren.Moraski@ee.doe.gov
- Link to database: http://energy.sandia.gov/energy/renewable-energy/water-power/technology-development/advanced-materials/mhk-materials-database/