

Wind, Water, and the “NWTC”

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Director – National Wind Technology Center

Component and System Characterization and Optimization:

Structural, Drivetrain, Sensors, Instrumentation, Controls, System Integration

Grid: Integration, Power Electronics, Ancillary Services, Fault Response, HIL Microgrid

Technoeconomic Analysis:

LCOE, System Cost Analysis, Power Markets, Jobs, Economic Development Impacts

Modeling and Simulation: CFD, Mooring, Multi-body dynamics, Hydrodynamics, Controls

System Engineering: Offshore Structural Standards, Metocean Design Basis

Deployment / Stakeholder Engagement and Outreach

Sub-system Characterization

Levering past DOE investments for multiple industries



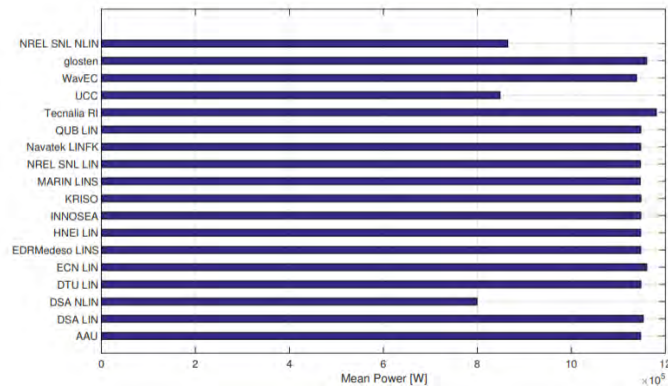
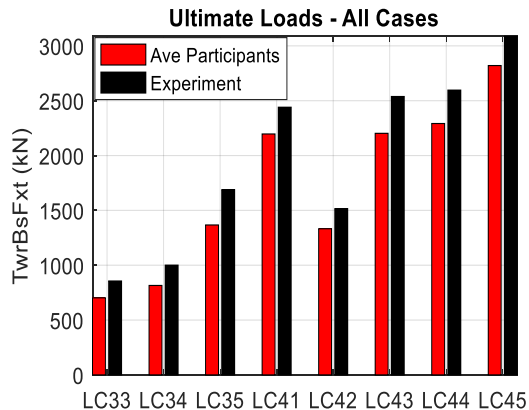
IEA Wind Task 30

Verification and validation of offshore wind modeling tools (OC3-OC6)

IEA Ocean Energy Systems Task 10

Verification and validation of wave energy converter modeling

- Those developing and using modeling tools involved – designers, certifiers, consultants, developers, and researchers
- IEA Ocean Energy Systems Task 10 modeled after IEA Wind Task 30



International Energy Agency (IEA) projects led by NREL/Sandia are verifying and validating the engineering-level tools for offshore wind and wave energy design

Developing the next generation high-fidelity modeling tool

Objective:

- Advance the scientific understanding of the multi-scale flow physics and turbine dynamics of land-based and offshore wind turbines and farms
- Provide the community with a high-fidelity open source simulation capability that can run on “leadership class” supercomputers

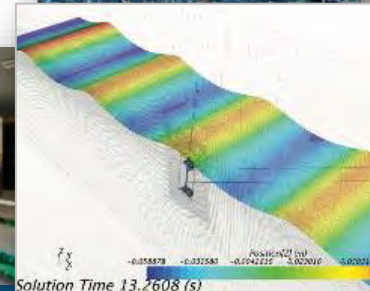
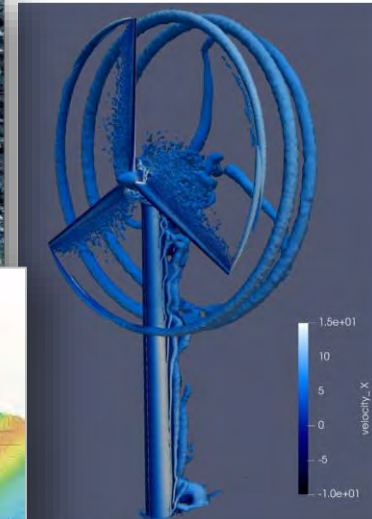
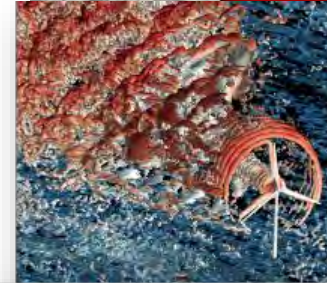
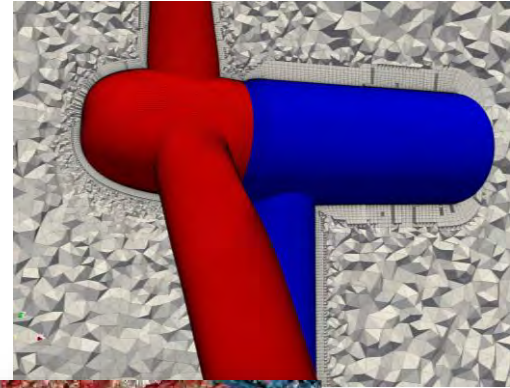
Project is a collaboration between the DOE **Office of Science**, the DOE **Wind Program**, **NREL**, and **Sandia**.

Project webpage: <https://github.com/Exawind/nalu-wind>

The team has proposed FY19 work (via the DOE merit review process) to develop floating wind turbine modeling capabilities → **Opportunity for Wind-MHK collaboration!**

The proposed simulation capabilities could be directly used by the MHK industry to:

- Study physics at unprecedented levels of detail
- Model extreme conditions (e.g. ocean storms)
- Improve reduced order design tools (e.g. WEC-Sim)



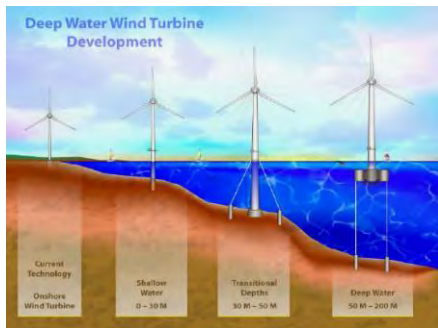
6 Sediment Stability and Environmental Risk

Risk: Harmful interaction between OW sub-structures/cables and the seafloor & unwanted environmental change.

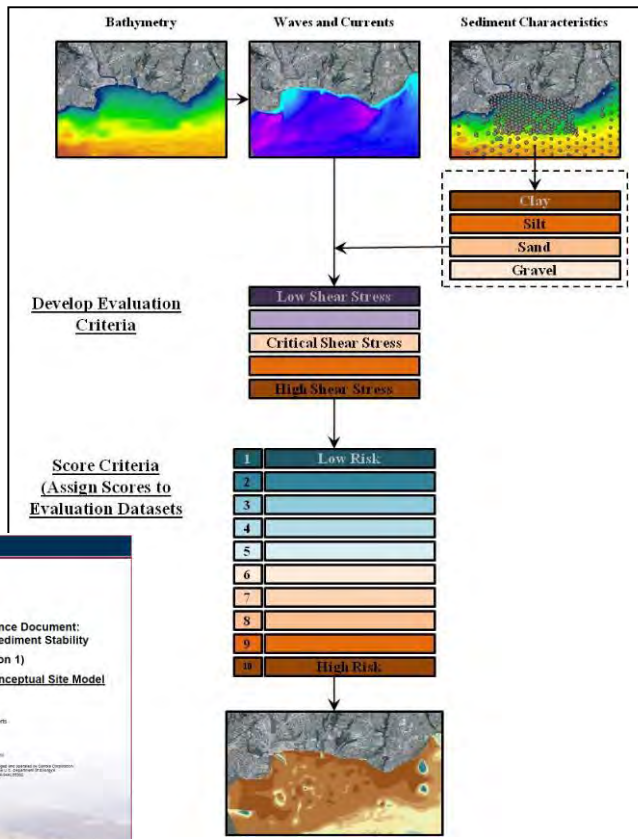
Approach: Use coupled hydrodynamic and sediment transport models to assess spatial patterns of likely erosion, transport, and deposition.

Purpose: Provide tools and guidance to quantify seafloor processes

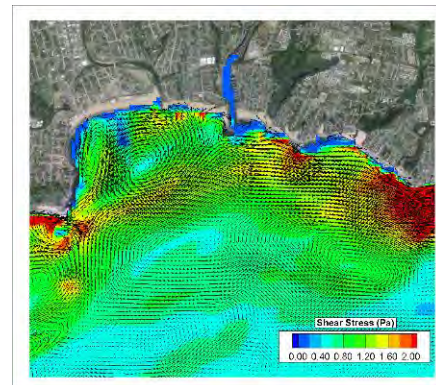
- Mitigate infrastructure scour risk.
- Retire/mitigate environmental risk



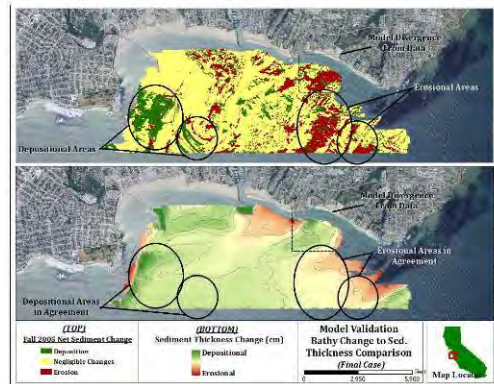
Sediment Stability Risk Framework



Bed Shear Stress Change and Velocity Vectors



Site Data (top) vs. Model Prediction (bottom)



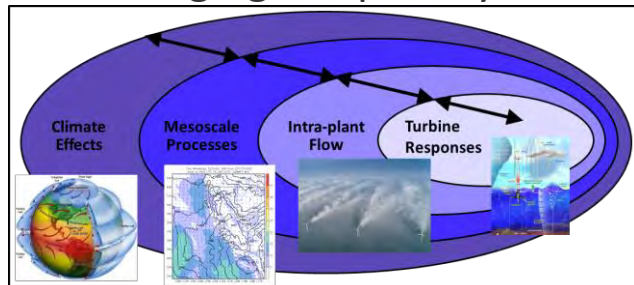




NREL/NWTC Wind Energy Research

Wind Plant Focused: 1993-present

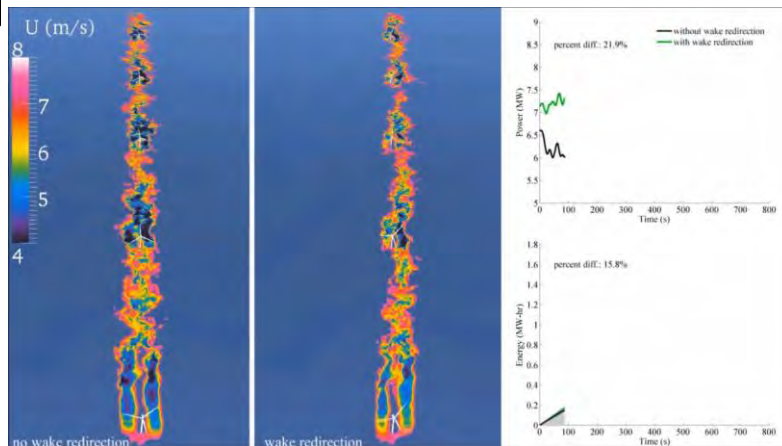
Challenging Coupled Systems



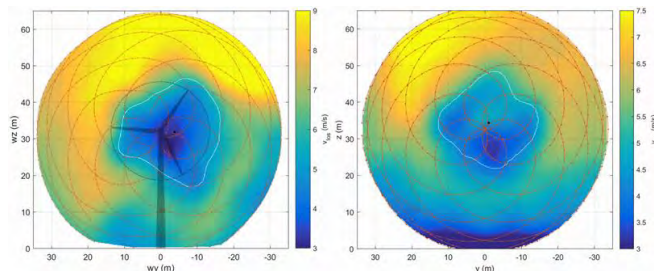
Turbine Controls



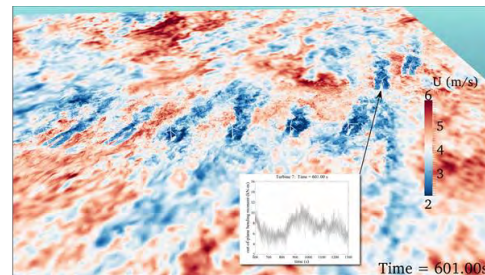
Wake Steering



Improving the performance of wind plants

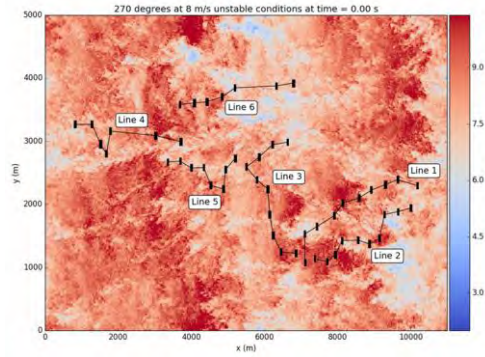


Advanced Sensing



Wind Plant Flow

Transmission and Grid Impacts



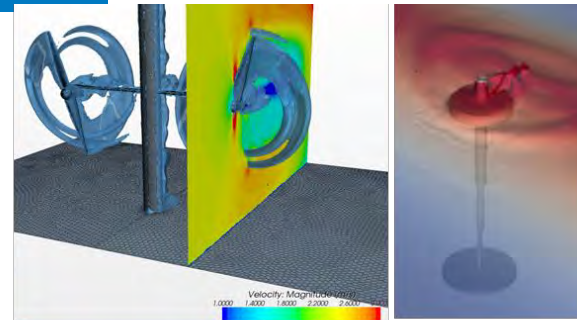
NREL/NWTC Water Power Mission

2008-present

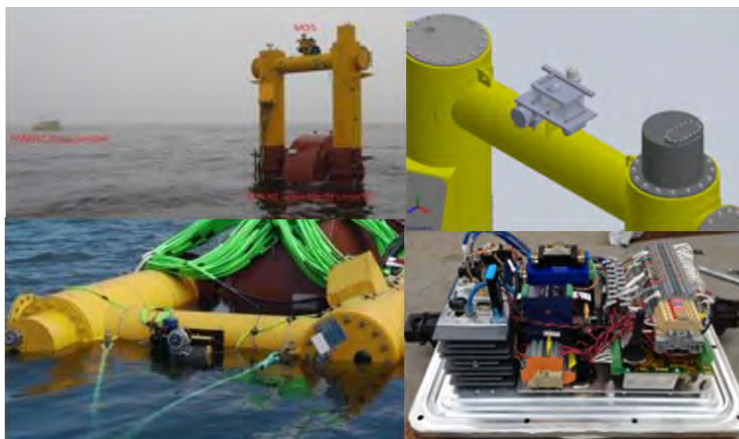
Leveraging
“wind”
facilities
and
capabilities



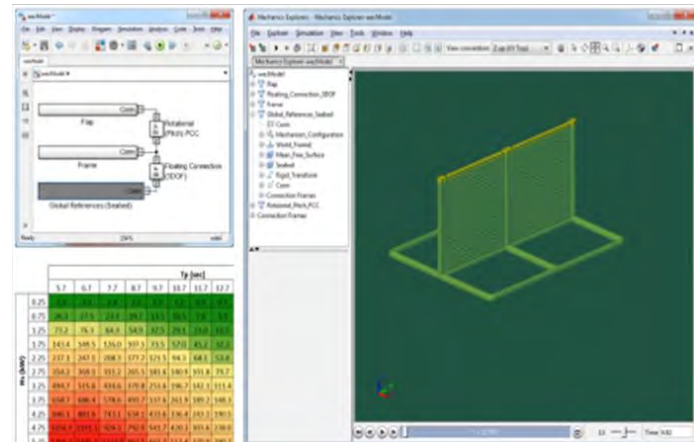
Drivetrain and component research



High fidelity numerical modeling



Characterization in operating conditions



Design tool development

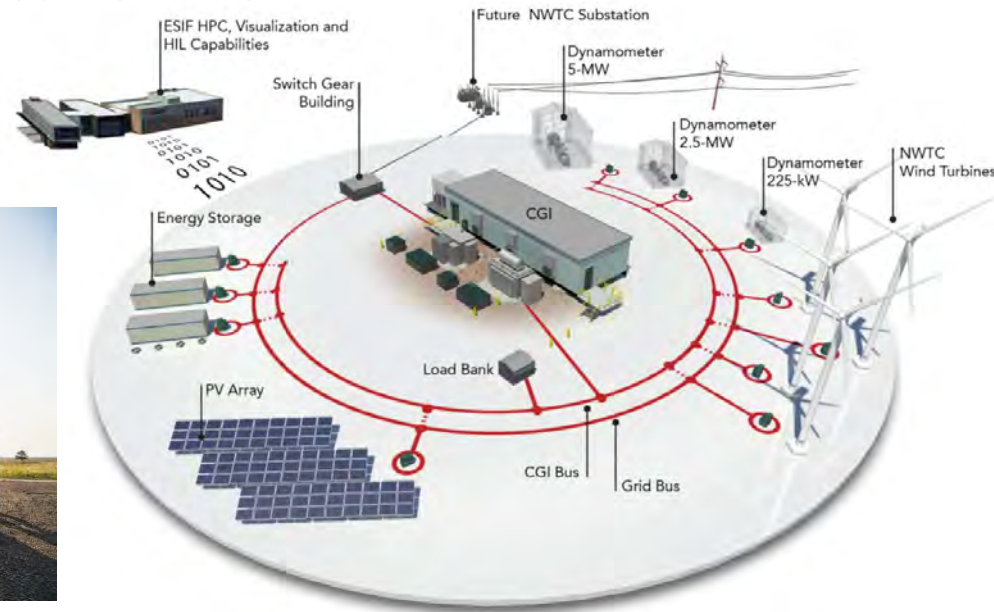
NREL/NWTC Grid Integration Research

2013-present

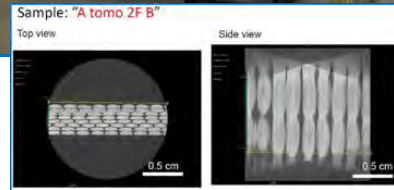
- Rapidly growing portion of research portfolio
- NWTC facilities provide flexible micro-grid capabilities with multi-MW generation and storage with ability to create grid faults isolated from the local utility
- **Very high level of industry interest**



Large-scale hardware rather than pure simulation



NREL/NWTC Manufacturing Research 2015-Present



DOE Request For Information



National Wind Technology Center Facility and Infrastructure Investments

DATE: July 27, 2018

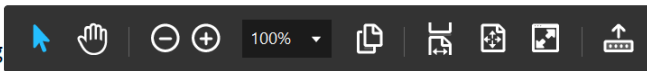
SUBJECT: Request for Information (RFI)

PURPOSE: Addressing the growing Research and Development (R&D) Interest in the use of the National Renewable Energy Laboratory's (NREL's) National Wind Technology Center (NWTC) facilities for renewable energy, energy storage, and grid integration technology development and testing.

Description

NREL's NWTC is poised to provide the integration, data collection, and test support services for a much broader and longer-term vision wherein renewables are a principal electricity provider for the nation. Consequently, the Office of Energy Efficiency and Renewable Energy (EERE) is issuing a Request for Information (RFI) to gain input from industry, academia, research laboratories, government agencies, and other stakeholders regarding infrastructure or equipment investments that would enable expanded energy R&D opportunities at the NWTC. EERE's vision is to enable the transition of the facility from a predominantly wind focus to a broader mix of energy research and development, including energy storage and grid integration.

EERE's Technology



structure

investments which would enable new research and development of value to industry R&D

Virtual Connections to Offsite Resources



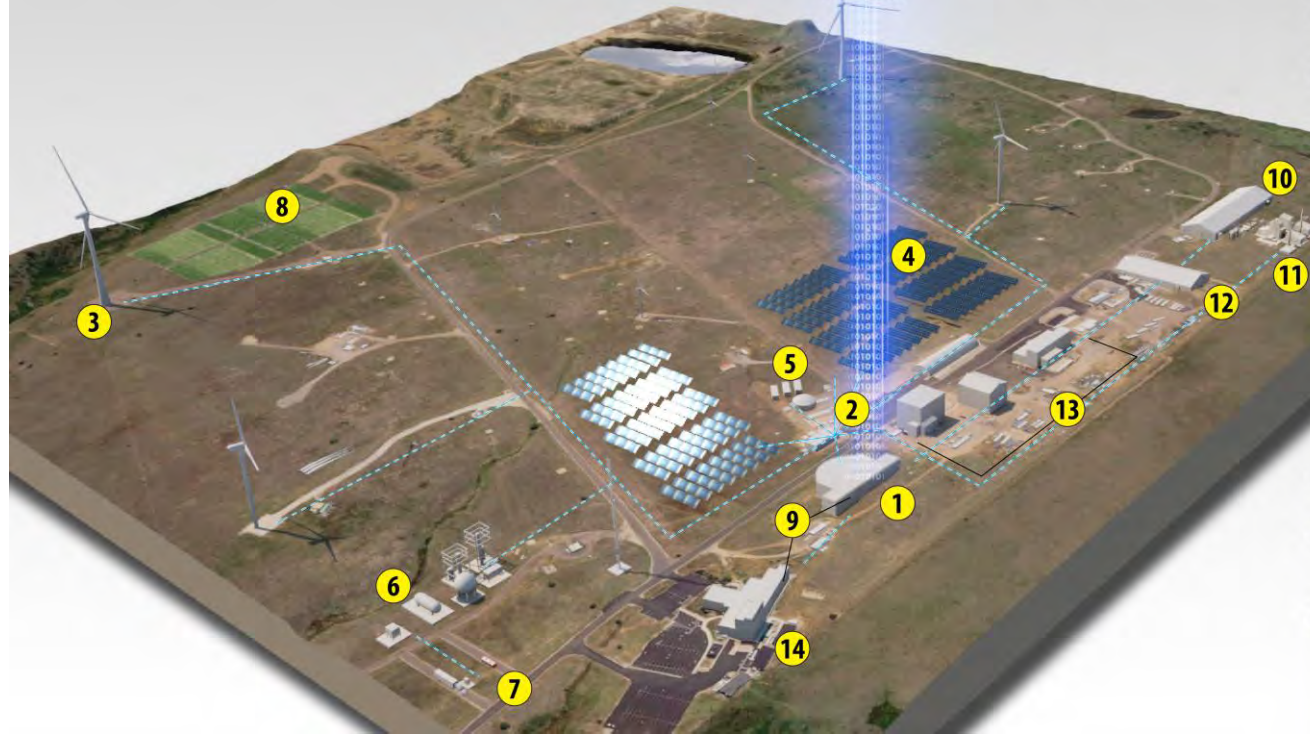
Hydropower

ESIF

DOE Labs
Nuclear

Offshore

Geothermal



- 1 Large-Scale Energy Integration and HPC
- 2 Enhanced Controllable Grid Interface
- 3 4+ Megawatt Wind Turbines
- 4 Photovoltaic Arrays
- 5 Energy Storage
- 6 Hydrogen
- 7 H2/EV Station
- 8 Biomass
- 9 Grid-Interactive Efficient Buildings
- 10 Advanced Manufacturing Facility
- 11 Natural Gas Plant
- 12 Electrons-to-X
- 13 Enhanced MHK / Hydro Capabilities
- 14 Water Power / DW Lab

Thank You