Center for Energy and Environmental Sustainability

Offshore Wind Energy Thrust Area

EAB/ISC Meeting
September 17, 2021

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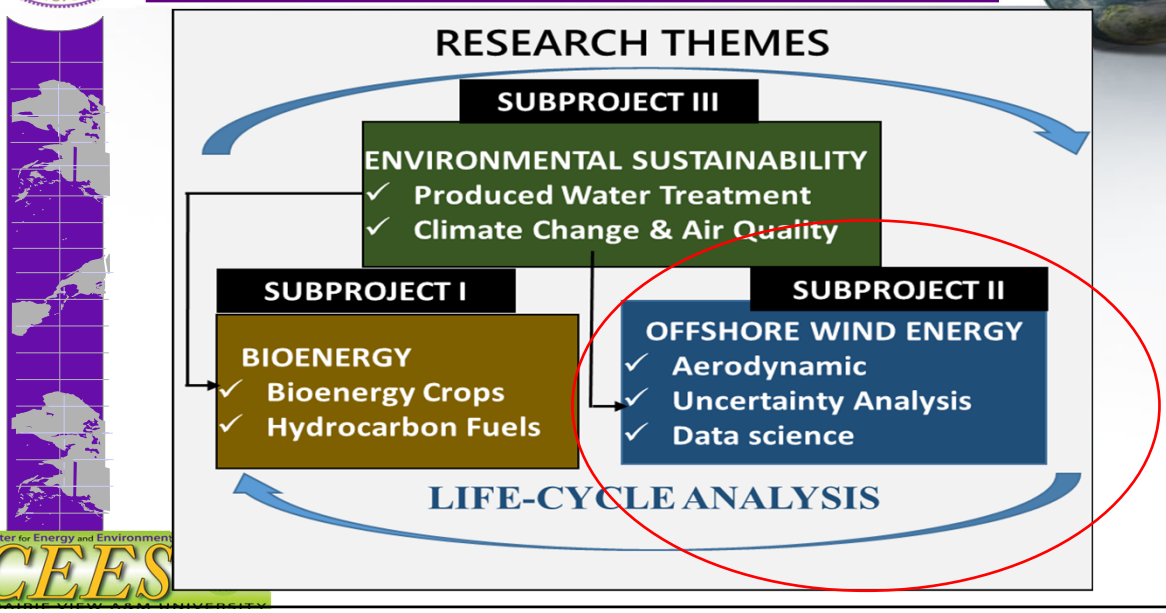
CEES Phase II Research Thrusts



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Phase I - Wind Energy

The major objective of this subproject was to determine the optimum design of wind turbine blades by applying multi-objective techniques with surrogate models.

Tasks

- Task 1: To improve understanding of the complex flow field around wind turbine blades and determine the relevant aerodynamic loads on the blades.
- Task 2: To perform structural analysis of the turbine blades using Finite Element Method.
- Task 3: To perform multi-objective optimization of the rotor blades using surrogate models.

Projects

- Aerodynamic loads using computational fluid dynamics (CFD)
- Structural analysis of blades with finite element methods (FEM)
- Blade shape: NREL Phase VI, pointed tip, winglet, gurney flap
- Design Optimization

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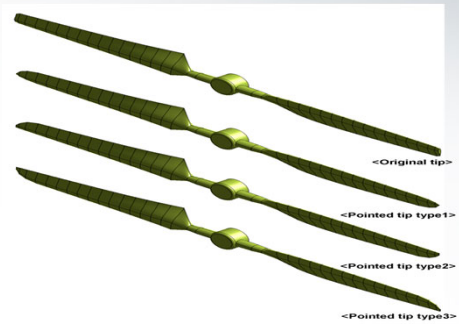
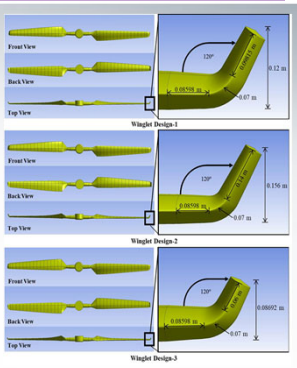
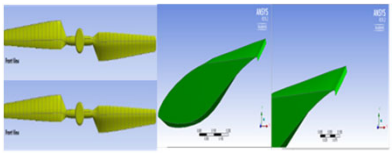
Phase I -Wind Energy







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Phase I - Wind Energy

Achievements

- 11 students graduated with MS degree
  - 3 students went to PhD programs
- 30 journal publications and book chapter
- 15 conference proceedings
- 37 conference presentations

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Phase II - Offshore Wind Energy

Group

- Dr. Ziaul Huque (Mech Eng), Group Leader
- Dr. Doeun Choe (Civil Eng) – No longer with the university

Goals

- Investigate current challenges of Floating Offshore Wind Turbines (FOWT)
- Improving the feasibility, efficiency, and cost-effectiveness of the offshore wind energy technologies

Three focus areas:

1. Improve blade aerodynamics prediction for FOWT
2. Model and analyze structural uncertainty in the FOWT system
3. Data science of damage risk assessment for FOWT blade

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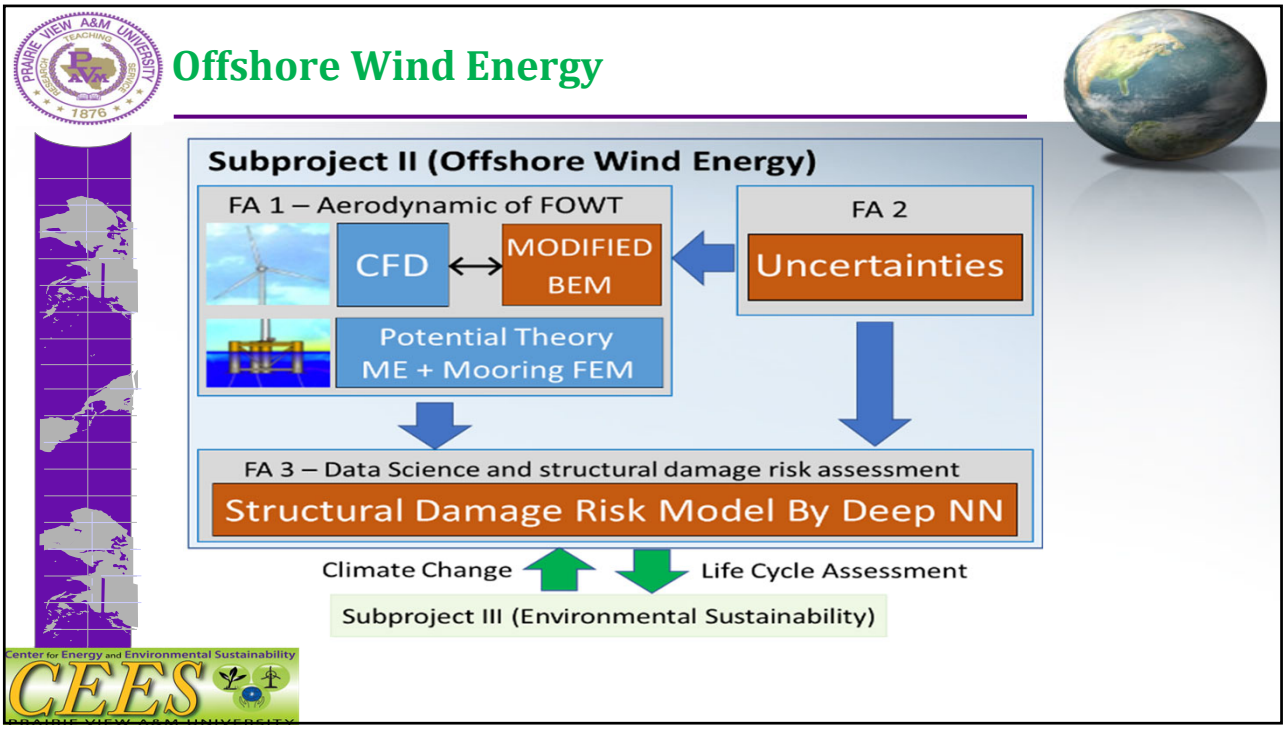

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OFocus Area 1: Improve blade aerodynamics prediction for FOWT:

- Task 1. Creation of CFD model for an On-land NREL 5MW wind turbine
- Task 2. Aero-hydro-mooring coupled analysis – BEM + Potential Theory-Based Approach
- Task 3. Aero-hydro-mooring coupled analysis – CFD + Potential Theory-Based Approach
- Task 4. Create correction factors for modified BEM modeling of FOWT

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OFocus Area 2: Model and analyze structural uncertainty in the FOWT system:

- Task 1. Estimate Safety Factors and Uncertainties for Structural Design of FOWT
- Task 2. Life-cycle Fragility Analyses

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OFocus Area 3: Data science of damage risk assessment for FOWT blade:

- Task 1. Phase II - Subproject II: Offshore Wind Energy and process of numerical sensor data
- Task 2. DNN modeling for SHM 2. Life-cycle Fragility Analyses
- Task 3. Risk assessment for structural damage using the DNN model
- Task 4. Develop the framework of structural health monitoring using DL

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- **Projects Completed**
  - Comparison study of structural health monitoring of wind blade using numerical simulation between Elastodyn and Beamdyn
- **Goals and Objective**
  - To provide an efficient vibration-based health monitoring method of FOWT wind blade
  - To inspect the feasibility for wind blades through time-domain simulation
  - To detect damage done based on the modal properties as compared to the intact condition
  - To obtain information through numerical simulation that should help in decision making in the maintenance of the entire field

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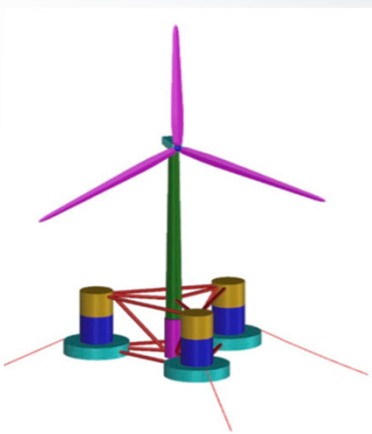
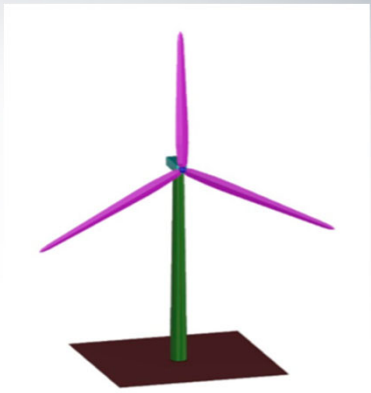
- On-Land and Offshore Wind-Turbine Configurations





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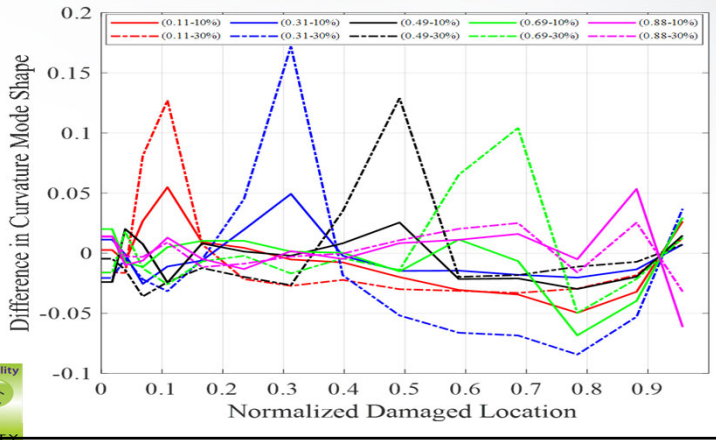
- The damaged location and the extent of damage were determined by plotting the Curvature modes shapes of the damaged and intact conditions as a function of location as shown in the figure



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Phase II - Subproject II: Offshore Wind Energy

- Future Work
  - Develop and validating a CFD-based-BEM model that accounts for marine environment effects such as platform pitch motion.
  - Develop and validate probabilistic models that accurately represent the coupled dynamics of turbine blades and supporting floating body
  - Determine the impact of the parameter uncertainties on FOWT structural safety.
  - Test out the feasibility of machine learning
  - develop the framework of structural health monitoring using machine learning-deep learning.

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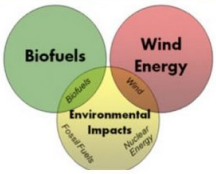

Questions/Further Information?
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