Addressing Challenges in Energy: Floating Wind in a Changing Climate (ACE-FWICC)

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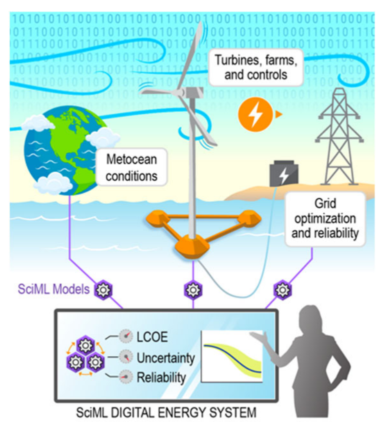
The challenges presented by the widespread and rapid deployment of floating offshore wind are complex and interdisciplinary. An integrated approach is required for floating offshore wind energy to reach cost and schedule goals that cannot be effectively met with siloed research focused on a subset of scientific gaps. The Center will develop a digital energy system using scientific machine learning (SciML) that links the key components of floating offshore wind driving the cost of power in a changing climate. These components of our Center's SciML Digital Energy System include the wind resource, wind, and wave (metocean) conditions, wind plant design and control, and integration of wind energy onto the power grid. In today's computational environment, it is impossible to practically use the existing suite of models to examine the cost of energy associated with the large-scale deployment of floating offshore wind turbines (FOWTs). The digital energy system will be constructed using SciML techniques, leveraging the domain-specific models and the Center's computational expertise. The primary advantage of the digital energy system is its ability to model FOWTs, wind farms, and wind power distribution in a coherent and computationally efficient way, enabling the development of new strategies to reduce energy costs in current and future climates. The Center's research falls into four themes: Metocean, Turbine and Farm, Grid, and SciML Digital Energy System. The Center has four objectives that map to the four research themes:

- <u>Objective 1</u>: Determine how the wind resource and metocean environment (including the impact of extreme events) will change on time scales ranging from weeks to decades.
- <u>Objective 2</u>: Enable levelized cost of energy (LCOE) reduction via improved control of FOWTs and wind farms—considering turbine lifetime, wake interactions, and grid integration—in current and future metocean environments.
- <u>Objective 3</u>: Determine optimal system designs for economic and reliable operation of the grid and efficient transport of power from offshore floating wind turbines in present and future climates.



- Objective 4: Develop a digital energy system model using SciML to test and evaluate the impact of uncertain changes in the wind resource and metocean conditions on FOWTs, wind farms, and the reliable and optimized integration of wind energy in the grid.

The Center will support the Earthshot goal of reducing LCOE and will integrate research across four themes. First, research in the Metocean Theme will improve estimates of the wind resource and metocean conditions on time scales ranging from days to decades, as well as add a treatment of farm-to-farm wakes. Second, work in the Turbine and Farm Theme will improve wind plant controls, leading to decreased maintenance costs, increased turbine lifetime, and better accounting for turbine-to-turbine wakes using realistic conditions delivered from the Metocean Theme. Third, research in the Grid Theme will improve planning and operation of the grid, accounting for the variability and intermittency of FOWTs. The results of these three themes will inform each other and will provide the basis for the SciML Digital Energy System Theme.

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