

## **ABSTRACT**

Offshore wind farms' layout can markedly influence the power production and maintenance of projects. The wind farm layouts are designed based on wind resources, dimensions of the project areas, sea conditions, and environmental considerations. Turbine wakes decrease the power output of the wind farms and increase the load of downwind turbines. Therefore, turbine wakes play a critical role in the optimal positioning of wind turbines in offshore wind farms. We propose to develop and validate data-driven physics-based machine learning-based models that allow for affordable and yet reliable prediction of the 3D flow field and power production of the utility-scale offshore wind farms. The proposed models will be developed and validated using data obtained from high-fidelity simulations and enable effective prediction of flow field and power production of various offshore wind farm layouts and, subsequently, optimization of the wind turbine positioning to maximize power production while minimizing fatigue of downwind turbines. *Compared to the conventional high-fidelity models that require hundreds (if not thousands) of CPUs on computing clusters, the proposed modeling tools can effectively run on a single GPU (or a CPU) and, thus, are affordable enough to be utilized by the practicing engineers. This project will allow us to obtain critical preliminary data to prepare and submit a multi-million-dollar grant proposal to the US Department of Energy in the academic year 2023.*