

Enabling Offshore Wind Energy via Physics-Guided Spatio-Temporal Data Science: Towards Accurate Probabilistic Forecasting with AIRU-WRF

Dr. Ahmed Aziz Ezzat

Assistant Professor
Industrial & Systems Engineering
Rutgers University

Abstract: The United States has set an ambitious plan to ramp up its offshore wind industry by facilitating several large-scale offshore wind developments off its Atlantic coastline. While those offshore wind projects hold great promise, both environmentally and economically, their reliable operation and integration into the land-based power grid will be contingent on accurate, high-resolution forecasts of the offshore wind resource. To that end, I will present a spatio-temporal data science model, called the AI-powered Rutgers University Weather Research and Forecasting (AIRU-WRF) model, which integrates physics-based numerical weather predictions with high-resolution measurements, in order to make turbine-specific, short-term wind forecasts in the U.S. North Atlantic offshore wind energy area. In contrast to black-box machine learning or purely physics-based methods, AIRU-WRF is a “physics-guided” statistical approach, i.e., it is designed to capture salient physical features of the offshore wind field, without the need to explicitly solve for those physics. Tested on actual measurements from the New York/New Jersey Bight—in vicinity to at least three ongoing offshore wind project developments—the forecasts made via AIRU-WRF are shown to significantly outperform numerical weather predictions, as well as those obtained via prevalent benchmarks in the forecasting literature and practice, providing a testament to the promise of physics-guided data science for offshore wind energy. I will then conclude by providing a glimpse about some of our related ongoing work on optimal, forecast-informed operations in offshore wind farms.

Bio: Dr. Ahmed Aziz Ezzat is an Assistant Professor of Industrial & Systems Engineering at Rutgers University, where he leads the Renewables & Industrial Analytics (RIA) research group [[RIA Research Group](#)]. Before joining Rutgers, Dr. Aziz Ezzat received his Ph.D. from Texas A&M University in 2019, and his B.Sc. degree from the Arab Academy for Science and Technology in Alexandria, Egypt, in 2013, both in Industrial Engineering. His broad research interests are in the areas of spatio-temporal data and decision sciences, probabilistic forecasting, quality and reliability engineering, with focus on renewable energy analytics and industrial/materials informatics. Dr. Aziz Ezzat is the recipient of the 2020 IIF-SAS[®] research award from the Institute of International Forecasters, the 2020 Rutgers OAT Teaching Award, the 2019 ISEN Outstanding Graduate Student at Texas A&M, and the 2018 INFORMS Outstanding Member of the Year at Texas A&M. He is an elected board member at the Energy Systems (ES), and the Quality Control & Reliability Engineering (QCRE) divisions of IISE, and is part of the leadership team of the Forecasting for Social Good (F4SG) Initiative. His research is supported by the National Science Foundation (NSF), The NJ State Economic Development Authority, Institute of International Forecasters and SAS corporation, and the Rutgers Energy Institute. He is a member of INFORMS, IEEE-PES, and IISE.